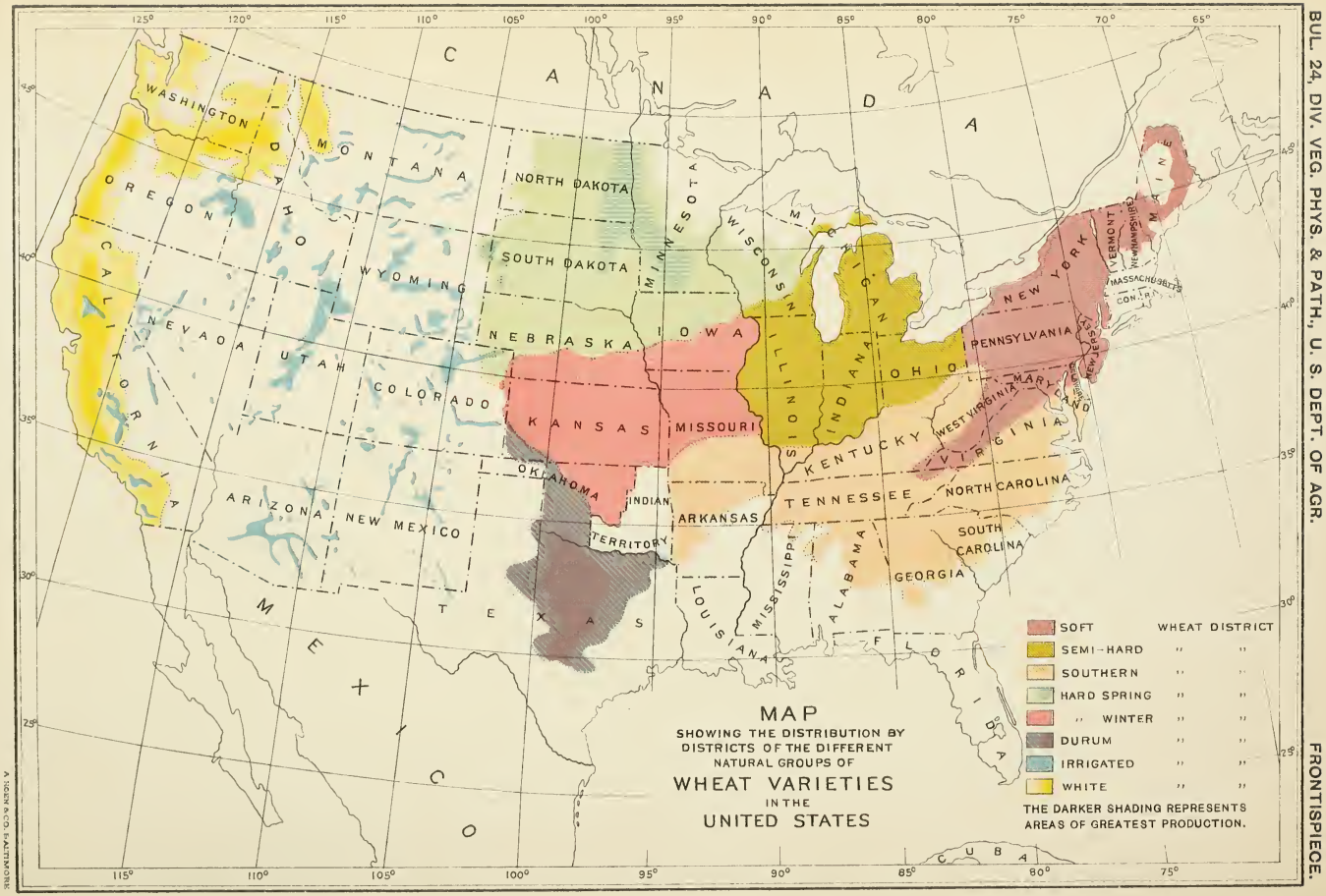

WASHINGTON
OREGON
CALIFORNIA
IDAHO
MONTANA
NEVADA
UTAH
WYOMING
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
INDIAN TERRITORY
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MARYLAND
DELAWARE
NEW JERSEY
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONN.
R. I.
MAINE
CANADA
MEXICO
CUBA
SOFT WHEAT DISTRICT
SEMI-HARD " "
SOUTHERN " "
HARD SPRING " "
" WINTER " "
DURUM " "
IRRIGATED " "
WHITE " "
THE DARKER SHADING REPRESENTS AREAS OF GREATEST PRODUCTION.
MAP
SHOWING THE DISTRIBUTION BY DISTRICTS OF THE DIFFERENT NATURAL GROUPS OF
WHEAT VARIETIES
IN THE
UNITED STATES
A. HOEN & CO. LITH. BALTIMORE

BULLETIN NO. 24. V. P. P.—77.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

B. T. GALLOWAY, Chief.

THE BASIS FOR THE IMPROVEMENT OF AMERICAN WHEATS.

BY

MARK ALFRED CARLETON,

Cerealist, Division of Vegetable Physiology and Pathology.

ISSUED DECEMBER 10, 1900.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1900.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Vegetable Physiology and Pathology,
Washington, D. C., July 19, 1900.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 24 of this Division, the manuscript of a paper by Mr. M. A. Carleton, on The Basis for the Improvement of American Wheats. During the past ten years this Division has had under investigation a number of problems connected with cereal production, and in order to carry on this work intelligently it has been necessary to make a careful study of the wheat industry generally. To this end a thorough survey of the field has been made, and the results are brought together here. The bulletin will prove especially valuable as showing the lines along which further work must be carried on. Part of this work is already under way, and other lines will be taken up as rapidly as the means at hand will permit.

Respectfully,

B. T. Galloway,
Chief of Division.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Personal explorations	9
Characteristics and needs of the several wheat districts of the United States	9
General needs of all the districts	10
Yielding power	10
Early maturity	11
Soft wheat district	12
Semihard winter wheat district	13
Southern wheat district	14
Hard spring wheat district	15
Hard winter wheat district	17
Durum wheat district	18
Irrigated wheat district	20
White wheat district	22
Sources for desirable qualities	25
Characteristics of botanic groups of wheat	26
Common bread wheats (*Triticum vulgare*)	26
Club or square head wheats (*T. compactum*)	28
Poulard wheats (*T. turgidum*)	29
Durum wheats (*T. durum*)	30
Polish wheats (*T. polonicum*)	32
Spelt (*T. spelta*)	33
Emmer (*T. dicoccum*)	34
Einkorn (*T. monococcum*)	35
Geographic groups of wheats	36
Improvements accomplished	37
Introduction of new varieties	38
Work of the Department	40
Wheat breeding	63
Improvement by selection	64
Improvement by hybridization	69
Summary	77

ILLUSTRATIONS.

PLATES.

Page.

FRONTISPIECE. Map showing the distribution by districts of the different natural groups of wheat varieties in the United States.

PLATE I. Wheat field near Mount Vernon, Va 12

II. Fig. 1, Wheat fields of the Red River Valley near Grand Forks, N. Dak. Fig. 2, Self-binders at work near Grand Forks, N. Dak 16

III. Fig. 1, Field of wheat on "Tule" lands near Stockton, Cal. Fig. 2, Steam combined harvester-thresher harvesting on "Tule" lands near Stockton, Cal 22

IV. Fig. 1, Bags of wheat just harvested on the Bidwell estate, Chico, Cal. Fig. 2, Wheat field near Tehama, Cal 22

V. Fig. 1, Harvesting with the combined harvester-thresher near Walla Walla, Wash. Fig. 2, Wheat fields before and after harvesting, near Walla Walla, Wash 24

VI. Fig. 1, Combined harvester-thresher at work near Walla Walla, Wash. Fig. 2, Harvesting with the wide-cut binder near Colfax, Wash 28

VII. Spelts and Einkorns in experimental plats at Garrett Park, Md. 34

VIII. Fig. 1, Group of Russian wheats in experimental plats at Garrett Park, Md. Fig. 2, Experimental wheat plats at Garrett Park, Md., showing earliness of King's Jubilee 62

IX. Hybrid wheats, Early Arcadian and Diamond Grit, shown by the side of the parent varieties 72

X. A composite cross by the Gartons, showing samples of the progeny of the last cross 74

TEXT FIGURES.

FIG. 1. Diagram showing pedigree of Early Genesee Giant Wheat 71

2. Diagram showing pedigree of one of the Gartons' hybrid wheats 74

3. Diagram showing pedigree of one of the Gartons' hybrid wheats 75

4. Diagram showing pedigree of one of Farrer's hybrid wheats 76

5. Diagram showing hypothetical cross of wheat and spelt 76

THE BASIS FOR THE IMPROVEMENT OF AMERICAN WHEATS.

INTRODUCTION.

In 1894 the Division of Vegetable Physiology and Pathology began experiments on an extensive scale to test the comparative rust resistance of different varieties of cereals, especially wheat. This work was carried on for three seasons at Garrett Park, Md., Salina, Kans., and Manhattan, Kans., respectively. An account of the results of this work has already been published,[1] so that it is unnecessary to refer to them in detail here. Suffice it to say that in the course of the work it became apparent that constant rust resistance is not to be obtained among the ordinary bread wheats known at present, though on an average a few such varieties are fairly resistant during a long period of years. By the results obtained it was rendered highly probable that this quality must be bred into a variety either by rigid selection of the most resistant individuals of that variety or by crossing with resistant varieties of other wheat groups and selecting from the resultant progeny such types as combine in the highest degree the usual qualities of the bread-wheat group with that of rust resistance.

It was found, moreover, that in regard to other qualities than rust resistance it is not possible to obtain varieties which even approximate perfection, and especially is it rarely, if ever, true that many desirable qualities are found in the same variety. However rust resistant a certain variety may be, it will usually be found lacking in some other essential quality, and manifestly the most perfect rust resistance is of no consequence if other essential qualities are absent. As a rule the wheats that are most highly resistant to orange leaf rust[2] are not varieties of the common bread-wheat group (*Triticum vulgare*) at all, though it by no means follows that they can not be used in bread making. At the same time some of the most valuable sorts for bread flour, including a number of Russian varieties, rust very badly in certain seasons. Occasionally good qualities may neutralize bad ones

[1] Cereal Rusts of the United States, Bul. No. 16, Division of Vegetable Physiology and Pathology, U. S. Department of Agr., 1899, by M. A. Carleton.

[2] For descriptions of the two wheat rusts of this country and illustrations of their differences see Bul. No. 16 of this Division, above referred to.

in the same variety. For example, a variety may be very susceptible to rust when attacked, but usually be able to escape it by virtue of its quality of early maturity.

Consideration of such facts finally led to the determination to study thoroughly wheat varieties themselves in all their relations, and not simply wheat diseases. Such a study of course naturally presupposes the investigation of all associated problems, such as drought resistance, early maturity, yielding power, and other matters of great economic interest. The different phases of the subject of wheat culture in its broadest sense are so intimately connected that no one of them can be intelligently studied separate and apart from the others.

During the first season (1895) of the investigations above mentioned about one hundred crosses were attempted with wheat varieties (besides a number with varieties of oats), mainly to determine the facility with which hybrids might be produced by crossing varieties of quite different groups. One-third of these crosses resulted successfully, unless a few of them may possibly have resulted from accidental pollination. Some of them were readily effected between varieties of common wheat (*Triticum vulgare*) and the durums (*T. durum*), as well as between varieties of each of these groups and the poulards (*T. turgidum*). All the resulting hybrids were planted, but, the weather conditions of the following season being unusually severe, these and many of the other experimental varieties failed to survive.

This work was continued, but in the meantime careful studies were being made in the several wheat districts with a view of determining the particular needs of each. In some districts greater hardiness of winter sorts is required; in others, varieties with a particularly tenacious chaff; in others, stiffer straw; in others, drought resistance, and so on. Varieties bred for North Dakota and Minnesota are of no value for California, and the best varieties for Texas would be useless in Montana. But aside from these considerations a knowledge of the different botanical groups of wheats is necessary, in order to have at command all the sources from which may be drawn the qualities required for different districts.

After five years investigations it can by no means be assumed that a full knowledge of the conditions of wheat culture and the demands of the country has been attained by this Division. Nevertheless, it is now possible to establish a reasonably complete basis upon which intelligent and systematic work may be accomplished—work that either could not be accomplished at all from a narrower standpoint, or would require much more additional time than has been given to the acquirement of this foundation, and could not even then be as thoroughly done.

PERSONAL EXPLORATIONS.

At various times during the years 1894 to 1897 all the wheat States except New York, Pennsylvania, and the Pacific Coast States were pretty thoroughly explored by the writer, the conditions of soil and climate being noted and a careful study made of the nature and distribution of the wheat varieties. Finally, during the past season (1899), it became possible to make a similar investigation of such conditions in the Pacific coast and North Mountain States, special attention being given in this case to the region usually known as the Palouse Country, and also to wheat culture under irrigation. Naturally very valuable information was obtained through these personal observations, which will be of great use in future work in wheat improvement.

During the summer and autumn of 1898, under the direction of the Section of Seed and Plant Introduction of this Department, an exploration was made of the greater part of European Russia, including the Caucasus, and of a small portion of the Kirghiz Steppes, as well as of Hungary and Roumania, in search of additional cereals for this country. A general report of this work has been published.[1] In Hungary and Roumania no varieties better than our own were found that had not already been obtained from those countries. In Russia some very valuable sorts were secured, which together with four or five others yet to be received,[2] give this country now practically everything of importance in the line of wheats from that, the second greatest wheat country of the world. All these explorations have been of great value in furnishing a long-desired opportunity for a comparative study of wheat varieties and the conditions of wheat environment in different countries.

CHARACTERISTICS AND NEEDS OF THE SEVERAL WHEAT DISTRICTS OF THE UNITED STATES.

From the standpoint of investigations so far made concerning the conditions of wheat environment and the adaptations of varieties in the United States, the country may be considered as divided into eight wheat districts, each possessing characteristics quite different from those of the others. In fact, in some cases they are as different from each other as though they lay in different continents. They are as follows: (1) The Soft Wheat district, including mainly the New England and Middle States; (2) the Semihard Winter Wheat district, including the North Central States; (3) the Southern Wheat district, including the northern part of the Southern States; (4) the Hard Spring Wheat district, including the Northern States of the Plains;

[1] Russian Cereals adapted for Cultivation in the United States, Bul. No. 23, Division of Botany, U. S. Department of Agriculture, 1900, by M. A. Carleton.

[2] Since this was written these varieties have all been obtained.

(5) the Hard Winter Wheat district, including the Middle States of the Plains; (6) the Durum Wheat district, including a part of the Southern States of the Plains; (7) the Irrigated Wheat district, including in general the scattered portions of wheat area in the Rocky Mountain and Basin States; and (8) the White Wheat district, including the larger part of the Pacific Coast States. Just as these districts differ from each other in their characteristics, so do the particular needs of the wheat grower in each differ widely from those of other districts. (See colored map, frontispiece of this bulletin.[1])

GENERAL NEEDS OF ALL THE DISTRICTS.

Before describing these districts separately, it will be well to note briefly two general needs common to all of them. These are (1) greater yielding power and (2) earlier maturity. In the writer's experience these are found to be ever present needs, not only in all our own States but in all wheat countries.

YIELDING POWER.

This quality is of course always desirable, simply from the standpoint of obtaining the greatest possible profit from the same area. Nevertheless, on account of peculiar local conditions the demand for a large yield is given much more emphasis in some localities than in others. Besides, the need of a large yield does not always arise from the same cause, and in many cases it is not real, but only appears so because of defects in other regards. To illustrate, the Palouse country of Washington and Idaho may be taken as an example in contrast with that of the Southern States. In the Palouse country the regular average yield is already probably near 25 bushels per acre, while 35 or 40 bushels per acre is a common crop in certain seasons, and 60 bushels not particularly rare. Yet from no part of the country has the writer had more requests for information concerning larger-yielding varieties. As a matter of fact prices of wheat are proportionally so low on account of the great distance from good markets, and the method of summer fallowing, which allows a crop only every second year, is so

[1] It has been a most difficult matter to prepare this map, and it is not claimed that it is accurate. Indeed it would be impossible at present to prepare an accurate map of this nature. But it represents approximately the different wheat districts characterized mainly by the cultivation of certain natural groups of wheats. Of course the different groups will lap over more or less from one district to another. In all that part of the United States approximately east of the one hundred and fourth meridian the uncolored portions represent territory either from which we have no statistics, such as the Indian Territory, or in which the wheat production averages less than 1 bushel to the square mile. West of this line the white portion represents territory in which there is practically no wheat grown at all. The reports of the census of 1890 and those of the Irrigation Division of the Geological Survey have been of much help in the preparation of the map.

much practiced that to overcome losses in these directions exceedingly large yields are considered necessary in order that much profit may be gained in the end. On the other hand, in the Southern States the problem of increasing the yield is entirely independent of deficiencies in other regards, for the home demand alone is sufficient to make prices good as a rule; but the average yield is extremely low, being under 10 bushels per acre. It would add one-half to the profit in these States if the yield could be increased even to the average of the entire country (slightly over 13 bushels per acre). In the South manuring the land must also be practiced in order to obtain the best results, which is an item not at present considered in the West.

In the States of the Plains the actual average yield is also rather low (a little over 12 bushels), so that here, too, the reason for a demand for an increased yield is evident and is usually independent of other deficiencies.

The average yield for the United States is far lower than it ought to be. The yield for the semiarid districts, which is much less, can and should be as high as that for the entire country at present.

EARLY MATURITY.

There is no part of the United States where early maturing wheats are not desirable for one reason or another. The reasons are various in different localities. As before stated, early ripening varieties are, in most seasons, more likely to escape damage by rust. In a large portion of the country this is a very important matter for consideration, but especially so in the Southern States and the States east of the Mississippi River, where the whole wheat crop is occasionally entirely destroyed by this parasite. But the need of early maturity is most urgent in the Palouse country, as the shriveling effects of the annual drought in that region which sets in just before harvest may be avoided by the use of early varieties. In the North Central States and the Great Plains region early maturing and winter varieties are less liable to the ravages of chinch bugs than are late maturing and spring varieties. In all the Northern States early maturity also allows the variety a better chance to escape early autumn frosts.

There are instances in which late maturity is apparently an advantage, but such cases are rare.

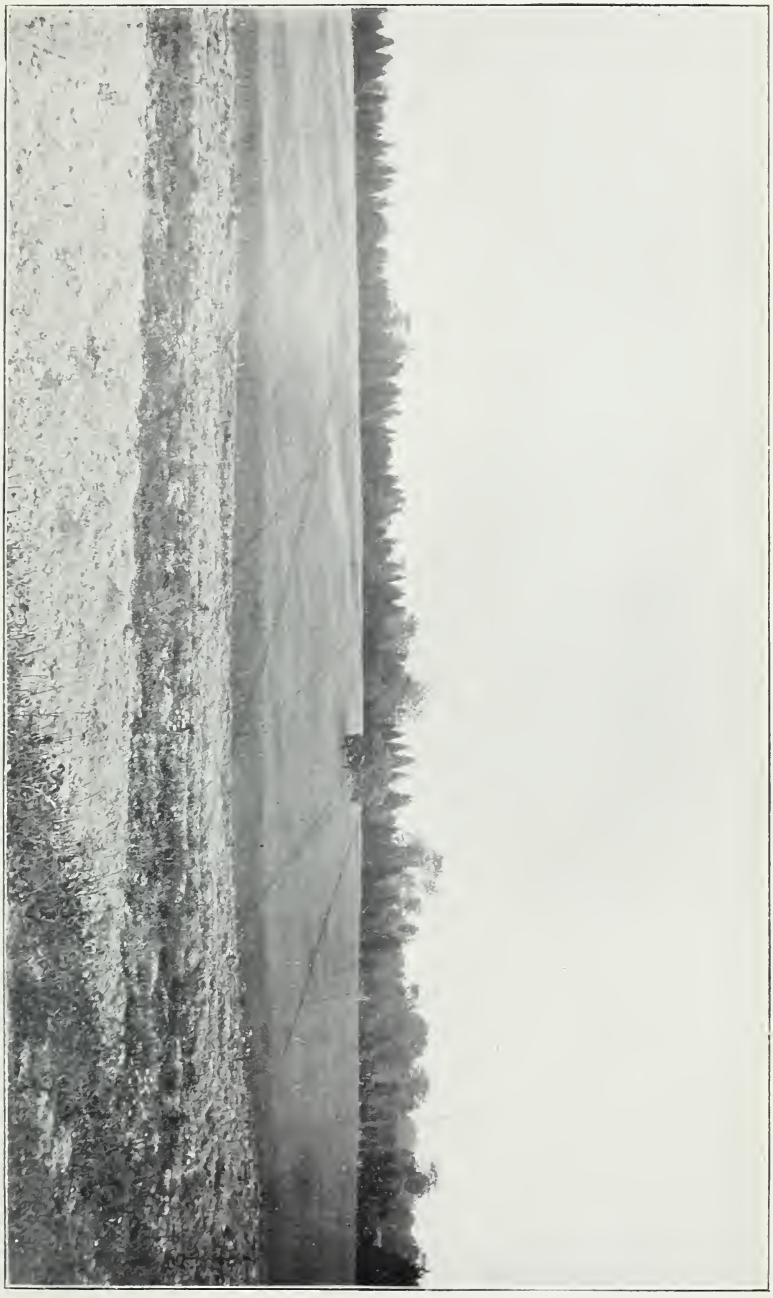
Finally it should be noted that there is quite a distinction between early wheats and early-sown wheats. A late-maturing wheat will ripen earlier than usual if sown earlier, or will ripen still later than usual if sown later. In the case of winter wheats early seeding allows the wheat plant to accumulate more reserve force in the roots during the autumn, thus enabling it to begin growth with greater vigor in the spring and get the start of the later-sown crops. In the case of spring sorts earlier seeding, of course, simply enables the crop to get an earlier start and

thereby to ripen earlier. By early sowing and the constant selection of the earliest ripening heads for seed a naturally late wheat may be gradually transformed into an early variety.

SOFT WHEAT DISTRICT.

In this district are included approximately New York, Pennsylvania, New Jersey, Maryland, Delaware, and portions of Virginia (Plate I), West Virginia, and eastern Kentucky; also such portions of New England as produce wheat to any considerable extent. The region is characterized on the whole by the production of rather soft wheats, containing a large amount proportionally of starch, though occasionally they incline to semihard. The color of the grain is usually yellowish white or amber, but sometimes quite reddish. The soil, especially if not heavily fertilized, does not possess the necessary amount of alkali, phosphate, and humified organic matter required for the production of hard, glutinous wheats. Moreover the climate is against their production, being too moist and cool in summer. Nevertheless in New York and Pennsylvania, by means of the plentiful application of fertilizers and the unusual attention paid to seed selection practiced in this region, a large amount of good wheat is annually grown in proportion to the entire area. Twenty-five or thirty years ago, when the area given to wheat culture in this country was much more limited than at present, and when the hard red wheats were not so popular, New York had a deservedly great reputation both for her wheat production and flour industry. And even at present, if there is a diminution of this reputation, it is not because of any actual decrease in wheat and flour production, but because of the overshadowing increase in districts more favorably conditioned or situated, though we should add to this the fact that there has been a corresponding change in the kind of wheat used for bread making. The fact that so high a standard is maintained in the wheats of this region in the face of adverse natural conditions, is strong proof of the importance of intelligent wheat culture, particularly in respect to seed selection and the proper treatment of the soil. In some localities of this district the standard is considerably above what one would expect, while in some other districts it is far below what it should be.

In the most northern portions of this district spring sowing is almost entirely practiced, and there is a need for hardy winter sorts which will be able to extend the winter-wheat area farther northward. In some localities rust is occasionally very injurious, the black stem rust sometimes completely destroying the crop. Early maturing and rust resistant sorts are therefore desirable for escaping or overcoming the attacks of this parasite.



WHEAT FIELD NEAR MOUNT VERNON, VA. (ORIGINAL.)

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Chief varieties now grown:

Fultz,	Fulcaster,
Early Genesee Giant,	Longberry,
Jones's Winter Fife,	Mediterranean,
Red Wonder,	Early Red Clawson,
Gold Coin,	Blue Stem.

(2) Average yield per acre, about $14\frac{2}{3}$ bushels.[1]

(3) Needs of the grower:

(*a*) Harder-grained, more glutinous varieties.

(*b*) Hardier winter varieties for the most northern portions.

(*c*) Early maturity.

(*d*) Rust resistance.

SEMIHARD WINTER WHEAT DISTRICT.

In this district we may include Ohio, Indiana, Illinois, Michigan, and a small part of Wisconsin. It produces a wheat of medium quality, and on the whole is one of the most important cereal regions of the United States. The wheats grown are generally semihard, rather reddish in color, and either bald or bearded. Throughout this district, as well as over a large portion of the country, there has been a decided tendency during the last twenty years or more toward the use of harder red wheats and also of a larger proportion of winter compared with spring varieties. The increasing use of the harder wheats has been coincident with the advent of the roller-milling process, but not necessarily a forced result of the latter, as some have inferred. The two have worked together. The proportion of such wheats now grown in this region is much larger than ten years ago. Especially is this true in Michigan, where special impetus has been given to such improvements through the efforts of Prof. R. C. Kedzie, assisted by the millers of the State. Similarly the area in which it is considered possible to grow winter wheats has been extended much farther northward, now including practically all of Michigan, nearly all of Illinois, and even a small portion of Wisconsin. Thus this group of States may now be properly called the semihard winter wheat district. These changes have been accomplished by the gradual introduction of hardier winter sorts, which are at the same time usually harder and red grained. Nevertheless there has been little more than a beginning in these improvements, and there is still a demand for hard red wheats, and in the northern portion of the region for hardier winter varieties.

The black stem rust is sometimes very destructive in these States, particularly in the lower, moist, and timbered portions of Ohio, Indiana, and Michigan. Hence there is great demand also for rust resistant sorts.

[1] Calculated as accurately as possible from data collected by the Division of Statistics of this Department covering the period 1890–1899.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Chief varieties now grown:

Fultz,	Poole,
Rudy,	Valley,
Early Red Clawson,	Nigger,

Dawson's Golden Chaff.

(2) Present average yield per acre, about 14 bushels.

(3) Present needs of the district:

(*a*) Hardness of grain.

(*b*) Rust resistance.

(*c*) Hardy winter varieties.

SOUTHERN WHEAT DISTRICT.

In area this district includes the larger portion of Kentucky, Virginia, West Virginia, and North Carolina, all of Tennessee, and portions of South Carolina, Georgia, Alabama, Arkansas, and Missouri. The annual production of wheat is comparatively small, and is furnished principally by Kentucky, Missouri, Tennessee, and Virginia. In the greater portion of the region the combination of great rainfall with mild temperature is not conducive to the greatest success in wheat growing. The soil is also generally not of the best for such purposes. Rust is always very bad, because of the constantly damp, warm climate. In spite of these difficulties there is no doubt that with sufficient effort the wheat industry might be very materially improved. Just recently there has been much interest awakened in the possibilities of successful wheat culture, particularly in Georgia and South Carolina. This increasing interest in the matter finally resulted in the calling together of a convention at Macon, Ga., in July, 1899, when it was unanimously decided that Georgia can very easily and should supply her own demands for wheat for bread making. Many members of the convention gave very favorable testimony regarding their own experiences in wheat growing during the past year. Probably one of the greatest obstacles in the way of profitable wheat raising in portions of the South is the lack of good flouring mills, much of the grinding being at present performed by the most primitive of gristmills. With a continued increase in wheat acreage there will perhaps be a corresponding increase in the number of first-class mills constructed.

On account of the severe rust attacks which occur in this district it is highly desirable to grow early ripening and rust resistant sorts. But there are really not many early maturing wheats grown in this country, and of the early foreign varieties already tested none have yet proved to be sufficiently hardy. Canning Downs, an early Australian sort, winterkilled even in so mild a region as Mississippi.[1] How-

[1]See Tracy, S. M. Wheat. Sixth Annual Report Mississippi Agricultural Experiment Station, 1893, pp. 23–25; also Eighth Annual Report, 1895, pp. 44–46.

ever, there has not been a sufficient number of trials of such varieties, and the different experiments have not been often enough repeated to give reliable results. As to the matter of rust resistance, experiments made in Louisiana[1] showed that hard red wheats, including a number of Russian origin, resisted rust the best. In Mississippi two Australian varieties, Beloturka and Defiance, were quite rust resistant, while varieties obtained from England rusted very badly.[2]

Occasionally wheat is much injured in the northern portion of this region by late spring frosts. It is on such occasions that late-maturing wheats and late-sown crops may have the advantage, since those ripening early are likely to be caught by the frost just at blooming time and be prevented from "filling out," while the later ripening crops, blooming after the frost, escape such injury. It seems possible, however, to grow varieties that will resist the action of these frosts, and therefore varieties hardy in this respect are desirable.

The wheats at present grown in the Southern Wheat district are either soft or semihard, and usually amber or reddish in color. They are either bearded, as in the case of the Fulcaster, or beardless, of which the Fultz and May wheats are examples. In Arkansas and the Carolinas, Nicaragua wheat, a durum variety, is grown somewhat, but to no great extent as yet. Wheat from the Southern States is always more likely to be infested with weevil than that from other districts, and occasionally much annoyance as well as injury to the grain results from this cause. Nicaragua and the hard red wheats are more resistant to weevil than are the soft wheats.

SUMMARY OF CONDITIONS AND NEEDS OF DISTRICT.

(1) Principal varieties at present grown:

Fultz,	Rice,
Fulcaster,	Everett's High Grade,
Red May,	Boughton,
Currell's Prolific,	Purple Straw.

(2) Present average yield per acre, about $9\frac{2}{3}$ bushels.

(3) Needs of the grower:

(*a*) Rust resistance.
(*b*) Early maturity.
(*c*) Resistance to late spring frosts.
(*d*) Stiffness of straw.

HARD SPRING WHEAT DISTRICT.

The hard spring wheat area comprises the States of Minnesota, North Dakota, South Dakota, the larger part of Wisconsin, portions of Iowa and Nebraska, and small portions of Montana and Colorado.

[1] See Stubbs, W. C. Experiments in wheat. Louisiana Agricultural Experiment Station Bulletin No. 19, 1892, 2d series, pp. 555–562.

[2] See Tracy, S. M., in Mississippi Agricultural Experiment Station reports above cited.

In this district, because of the rich, black soil and dry, hot summers, there is grown the highest grade of spring wheat in the world, excepting the spring varieties of the middle Volga region in Russia, which are very similar.

Two general types of wheat prevail throughout this district—the Velvet Blue Stem[1] and the Fife. A large proportion of the farmers in this region know no wheat which does not belong to one of these types. The chaff of the Velvet Blue Stem is covered rather closely with small hairs, and the plants are bluish gray near harvest time. In both types the heads are beardless and the grains are medium or small, hard, and red. There are several strains or varieties of each type. The gluten content of these wheats is comparatively very large, and especially of that quality which gives great lightness in bread making.

The average annual wheat production of this district is larger than that of any other similar area in the world, and is about 30 per cent of the entire production of the United States. The average yield per acre, however, is not very large—certainly far below what it might be. Almost everywhere the self-binder is used in harvesting the grain, and in some localities the farms given entirely to wheat culture cover many thousand acres. (See Plate II.) On these bonanza farms 50 to 100 self-binding harvesters are sometimes at work at the same time. The large size of the farms is one of the worst features connected with wheat growing in the Northwest. From this cause not enough attention is given to details of the work. Operations delegated to the best of foremen and other employees are never so carefully performed as when done under the direct scrutiny of the man who owns the farm, and whose interests are therefore at stake. Little things that are of importance when summed up are overlooked. The tillage is not thoroughly accomplished, weeds are not kept down, there is more or less waste of land, and the grain is allowed to degenerate in quality.

The needs of the grower in this district are not so great as in some others, though there is much to be desired. In the northern portion earliness of maturity is needed to enable the wheat to escape the early autumn frosts which sometimes catch the crop before harvest, while in the southern portion chinch-bug depredations and rust attacks might often be avoided through possession of the same quality. A combination of earliness and rust resistance in the same variety would be especially desirable. The average yield could be made very much larger, as already stated, but this is a matter depending fully as much on methods of culture as on the improvement of varieties. Proper seed selection,

[1] There are apparently four distinct varieties of so-called Blue Stem in the United States. The name Velvet Blue Stem is adopted here to designate the spring variety grown in this district. The one grown in the Palouse country will be called Palouse Blue Stem.

FIG. 1.—WHEAT FIELDS OF THE RED RIVER VALLEY, NEAR GRAND FORKS, N. DAK. (ORIGINAL.)

FIG. 2.—SELF-BINDERS AT WORK NEAR GRAND FORKS, N. DAK. (ORIGINAL.)

however, should be rigidly practiced. The establishment of hardy winter varieties in place of the spring varieties now grown would no doubt be an improvement of the utmost value in Iowa, Nebraska, and portions of Wisconsin, and perhaps a small part of Minnesota. This border is now the battle ground between winter and spring varieties, and it should be the constant aim to carry the line farther to the north, thus increasing more and more the winter-wheat area. Such purpose can be accomplished either (1) by the introduction of winter varieties, of similar quality to the spring sorts now grown, from the Crimea, north Caucasus, and southern Volga region of Russia, or (2) by the actual origination of hardier winter varieties of good quality through hybridization and selection. As an example of the effectiveness of the former method, we have only to point out the work already accomplished by Turkey wheat—a Crimean variety—in extending the winter-wheat area in Nebraska and Iowa.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Principal varieties at present grown:

Saskatchewan Fife,	Hayne's Blue Stem,
Scotch Fife,	Bolton's Blue Stem,
Powers Fife,	Wellman's Fife.

(2) Average yield per acre, about 13 bushels.

(3) Needs of the grower:

(*a*) Early maturity.
(*b*) Rust resistance.
(*c*) Hardy winter varieties.
(*d*) Drought resistance.

HARD WINTER WHEAT DISTRICT.

In this district is comprised approximately the middle States of the plains, including Kansas, a large part of Missouri, portions of Iowa and Nebraska, and the larger part of Oklahoma. As the name implies, it is characterized by the production of hard winter wheats, such wheats as are rarely found, but which are of the very best quality. The only other wheat region in all the world that is exactly comparable to this one, so far as known, is that including northern Crimea and the country directly between the Sea of Azov and the Caspian Sea. The latter region, however, at present produces better wheats than are produced in this district, and therefore should be drawn upon for all improvements that are attempted through introduced sorts.

The wheats of this district have slender, stiff stems, narrow compact heads, usually bearded, and medium or small, hard, red grains. In this region there is the most interesting example of the changes that may take place for the better in the development of the wheat industry. Twenty-five years ago the softer wheats (often white-grained) were chiefly grown over a large portion of this district, and

the cases of winter wheat sowing as against spring wheat sowing were much fewer than at present. Now the hard red-grained varieties are principally used, and only in Iowa and Nebraska are spring varieties grown to any extent. The introduction of these hard-grained winter sorts has added remarkably to the certainty and value of the wheat crop, and has greatly decreased the ravages from rust and chinch bugs.

Such improvements are after all but fairly begun, and there is yet great demand for hard-grained sorts and varieties that will resist the winters of Iowa and Nebraska. As the wheat area extends farther westward—to the one hundredth meridian and beyond—there is also a special need for drought-resistant sorts. In fact, in this and the district just described there is the most exacting demand of the entire country for hardy varieties. The extreme severity of the drought and winter cold combined forms a greater obstacle to winter wheat culture than exists in any other district. The average yield per acre is always low, but the problem in a considerable portion of the region is not so much to increase the yielding power per acre as to make sure of a crop every year, since there are so many complete failures from drought. A constant average of even 12 to 15 bushels per acre from year to year would be considered good.[1]

Early maturity is of importance in this district in order to allow an escape from the worst effects of the drought in the western portion and from the rust in the eastern portion. Rust resistance is also important, but not so much so as in States east of the Mississippi River.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Chief varieties at present grown:

Turkey, May,
Fulcaster, Zimmerman,
Fultz.

(2) Average yield per acre, about $12\frac{2}{3}$ bushels.

(3) Needs of the grower:

(*a*) Hardy winter varieties.
(*b*) Drought resistance.
(*c*) Early maturity.

DURUM WHEAT DISTRICT.

The area contained in this district is comparatively small and includes a large part of north-central Texas, the southwestern portion of Oklahoma, and a small portion of the southwest corner of Kansas. It also properly includes a portion of Colorado, but can not be so indicated on the map, as the particular portion is not yet definitely outlined. Some of this region (southwestern Oklahoma) has only

[1] The problem of successful wheat growing in arid regions is receiving earnest consideration and will be discussed in a later publication.

recently been opened to settlement, but wheat culture has developed rapidly in the new lands. The soil is generally black and rich in humus, just as in the district last described, and produces wheats with a large gluten content, which quality is further increased in the western portion by the dry, hot summer weather. The general demand is for hard-grained, drought-resistant varieties, and such sorts are already grown to a considerable extent. In recent years there has been an increasing tendency toward the cultivation of the durum or macaroni wheats, the chief variety grown so far being Nicaragua which has become quite popular. This variety is very hardy, yields well, and the grain is extremely hard and glutinous. It is quite similar to Kubanka, Arnautka, and other macaroni wheats grown in southern Russia, and for which there is so much demand in France and Italy. Notwithstanding the usual notion concerning such wheats, Nicaragua has been very successfully ground into flour by a well-known milling company at Fort Worth, Tex. By mixing slightly with other wheats an excellent bread flour is made. However, the chief profit to be gained from the cultivation of this variety in future will no doubt arise from its use in manufacturing macaroni, just so soon as the possibility of furnishing a sufficient supply becomes certain. Though its distribution is not yet very wide, Nicaragua is, nevertheless, grown over a large portion of Texas and also sparingly in Oklahoma and Colorado. For this reason, and because of the evident adaptation of such wheats to this region, it seems proper to call it the durum wheat district.

These durum wheats grow rapidly, are tall, and have wide leaves with a harsh surface, and large heavy-bearded heads, compactly formed. The grains are very large and long, and yellowish-white in color, becoming darker the blacker the soil in which the crop is grown. It being once proved that durum wheats succeed well, there is bound to be a still greater demand for them, so that the further introduction of such varieties becomes at once one of the needs of the district. Aside from macaroni varieties, the red-grained winter wheats, similar to those described for the Hard Winter Wheat district, are best adapted for the larger part of this region. The best example is the Mediterranean, which is very commonly grown.

In central and southwestern Texas rust is very destructive, so much so that wheat culture has been completely abandoned in many places on account of it. There is, therefore, a great demand for rust resistant varieties. The durum wheats have the advantage of being highly resistant to orange leaf rust, but succumb to black stem rust. In the western portion of the district the oft-recurring droughts are very detrimental, and therefore in that portion drought resistance and early maturity are important qualities.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Chief varieties at present grown:

Mediterranean,	Fulcaster,
Nicaragua,	Turkey.

(2) Average yield per acre, 11½ bushels.
(3) Needs of the grower:
  (*a*) Macaroni varieties.
  (*b*) Drought resistance.
  (*c*) Rust resistance.
  (*d*) Early maturity.

IRRIGATED WHEAT DISTRICT.

In this region is included all those scattered portions of the Rocky Mountain and Basin States in which wheat is grown at all. The States thus included are Wyoming, a part of Montana, southern Idaho, Utah, Nevada, Arizona, New Mexico, and the greater part of Colorado. In this district we find conditions remarkably different from those existing anywhere east of the Rocky Mountains. Three striking characteristics not present to so great a degree in any other district are (1) the extreme aridity, necessitating the application of water by irrigation, (2) the very low humus content of the soil, and (3) the superabundance of alkali usually present. These conditions are closely interrelated and mutually dependent upon one another. The absence of humus is a natural result of the absence of rainfall, upon which depends the existence of plant life. Rainfall also tends to equalize the distribution of the alkaline matters of the soil, which in this district, however, are concentrated, in places, in high percentages. The practice of irrigation is often allowed to make conditions worse by gradually carrying and depositing in certain localities or on certain farms an excess of alkali largely above that which was already present. These features of extreme aridity, lack of humus, and excess of alkali are so particularly characteristic that they go far beyond any matters of temperature dependent upon latitude or elevation in their effects upon the nature of wheat varieties grown in this district. That is, wheats so far north as southern Idaho are very like those of southern New Mexico or Arizona, and in all parts of the district show uniformly a great lack of gluten content, which is dependent mainly upon the presence of soil humus.

Wheat does best in soil that is alkaline rather than acid in reaction, but an excess of alkali becomes very injurious. Different cereals are able to withstand different amounts proportionally of alkali in the soil. Barley and rye seem to tolerate a larger proportion than wheat, and the latter will usually tolerate a larger amount than oats. Of all the cereals barley will withstand the largest amount.

The wheats of this district are almost always white-grained, soft, and

extremely starchy, and lack greatly in gluten content. The straw is so white and clean and glistening that it is dazzling to the eyes in the hot sunshine. Rust on wheat is seldom injurious, and in some localities is entirely unknown. Smut, however, is often present to a considerable extent. The stiffness of the straw and the absence of rain prevent the grain from ever lodging, so that harvesting may be delayed for weeks with little or no injury to the grain.

Manifestly the greatest need of this district is an increase in the gluten content of the grain. While the introduction of hard-grained nitrogenous sorts from other sections is at first an improvement, the gluten content can not thus be materially and permanently increased. No wheat variety, whatever its nature, can abstract from the soil elements that are not present there. Wheats brought from the black prairie soils of other sections to this district show the most striking illustration of the radical changes that may be caused in a variety by a simple transference to a new locality, and, even when grown under the best of care, quite effectually disprove a notion prevalent even among scientists that varieties will not deteriorate. The hardest red Fifes from North Dakota, Turkey wheat from Kansas, or Diamond Grit from New York become rapidly more starchy and of a lighter color on being grown in Utah or New Mexico. The first requisite, therefore, for wheat improvement in irrigated sections is the complete amelioration of the soil by (1) dispersing the excessive accumulations of alkali and (2) increasing the humus content through the application of nitrogenous fertilizers and the growth of leguminous crops in alternation with wheat. At the same time it will aid greatly to gradually introduce the harder red-grained wheats.

In many portions of this district, at high elevations in the mountains, wheat is often seriously damaged by early autumn frosts. It is therefore important to obtain for these localities the earliest maturing varieties possible, or varieties that may perhaps resist the action of the frost. For example, in the San Luis Valley of Colorado wheat is grown at an elevation of over 7,500 feet, where frost is likely to occur in any month of the year, but is especially liable to injure the crop in August.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Chief varieties now grown:

Sonora,	Little Club,
Taos,	Defiance,
Felspar,	Amethyst.

(2) Average yield per acre, about 21 bushels.

(3) Needs of the grower:

(*a*) Increase of the gluten content.

(*b*) Early maturity.

WHITE WHEAT DISTRICT.

This district covers, in a general way, the Pacific Coast region, including California, Oregon, Washington, and northern Idaho. All varieties that have become at all acclimated are characteristically white-grained, soft, and starchy. Usually the factor which is probably most influential in producing a grain of such nature is the lack of humus in the soil, as is true in the irrigated district. The generally cool summers, however, no doubt give aid to the same end. Hard red-grained varieties, when brought to this district, deteriorate in a few years time. Nevertheless such introductions have in a number of instances proved beneficial.

A majority of the more common varieties strictly characteristic of the district are of the group usually called club wheats and belong to the species *Triticum compactum*. Sonora, Defiance, and Australian of California, Red Chaff of Oregon (distinct from the Palouse Red Chaff of the Palouse country), and Palouse Blue Stem of Washington are not, however, club wheats. As the botanical name of the club group implies, these wheats have their spikelets (meshes) so compactly arranged in the heads that they stand out nearly at right angles with the rachis (or stem of the head). The head thus becomes squarely formed (hence the name square head applied to many of the varieties), and, being usually a little larger at the apex than at the base, appears club shaped. Thus, although the heads are usually rather short, each contains comparatively a large number of grains, which partially accounts, probably, for the large yields per acre in this district. Heads of Chili Club are occasionally found that contain over 160 grains each.

A very valuable characteristic of the club wheats is their ability to hold the grain in the chaff so that there is little danger of shattering, even during the driest season, if there should be much delay in the harvest. In some localities the grain, though ripening in July, is sometimes left standing till September before harvesting, a habit which, however, has no good excuse for its practice.

For the purpose of clearer discussion, the district may be considered as subdivided into three sections—California, Oregon, and the Palouse country of Washington and northern Idaho.

In southern California the varieties Sonora and Defiance are much grown, the latter particularly for its rust resistance, which is an important need in this part of the State. Sonora wheat has a reddish velvet chaff, is beardless, and is white-grained as seen in this district. The grain is a little harder than that of the club wheats and is used for export, while the grain of the latter is used for home consumption.

From the latitude of Fresno to the Oregon State line Australian and the various strains of club wheats are principally cultivated. The best known varieties that are given special names at all are Golden Gate Club, Salt Lake Club, and Chili Club. The variety Propo is also

FIG. 1.—FIELD OF WHEAT ON "TULE" LANDS NEAR STOCKTON, CAL. (ORIGINAL.)

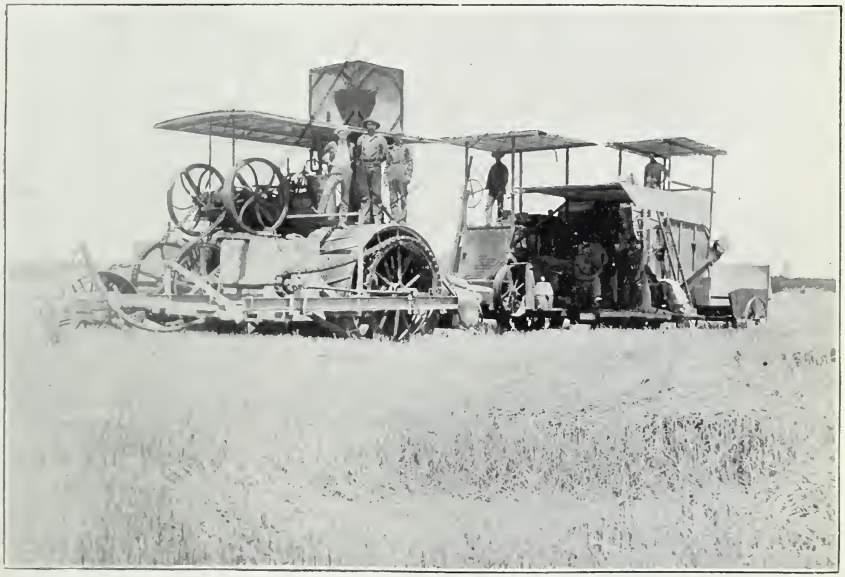


FIG. 2.—STEAM COMBINED HARVESTER-THRESHER HARVESTING ON "TULE" LANDS NEAR STOCKTON, CAL. (ORIGINAL.)

FIG. 8.—BAGS OF WHEAT JUST HARVESTED ON THE BIDWELL ESTATE, CHICO, CAL. (ORIGINAL.)

FIG. 2.—WHEAT FIELD NEAR TEHAMA, CAL. (ORIGINAL.)

grown to some extent. Other sorts from the East, such as Rudy, are occasionally introduced, but these do not seem to yield so well, and besides shatter so badly that they soon have to be given up. Nonshattering varieties are in great demand. In all portions of the State the increase of the gluten content is probably the greatest need. All varieties grown in the State are winter wheats.

One of the most interesting sections of California devoted to wheat culture is that of the "Tule" lands, near Stockton. (See Plate III, fig. 1.) The great grain fields there show strikingly the possibilities in a reclamation of immense marshes. They were once vast flats covered with water, mud, and a growth of bulrushes (*Scirpus lacustris*), called Tule in Spanish. By means of pumping, dredging, and throwing up levees these lands have been reclaimed, and now after many years they are among the most fertile of the State. Wheat yields from 50 to 80 bushels per acre here, and barley sometimes as much as a hundred bushels or more per acre. This remarkable fertility is a result, in part at least, of the deep deposits of organic matter. There is still apparently a lack of certain mineral ingredients, such as lime and potash, which are needed to make the quality of the grain as good as the quantity.

As in the case of the Hard Spring Wheat district the chief difficulty in the way of successful wheat culture in California, so far as agricultural practice is concerned, is the enormous size of many of the farms or ranches. They are even larger than in the Dakotas and Minnesota, containing often from 20,000 to 30,000 acres. On this account it is impossible to give the attention to details in farming that are necessary for the best results. The lack of attention to nitrogenous manuring, and especially to the alternation of wheat with leguminous crops, is particularly noticeable.

The combined harvester-thresher (Plate III, fig. 2) is used in harvesting pretty generally throughout the State. This machine is either drawn with an engine or with 28 to 40 horses. By its use the grain is thrashed directly from the field, and left piled in bags. (See Plate IV, fig. 1.) Immense ricks of these bags of grain remain in the field sometimes for weeks unmolested and undamaged by the weather. All grain throughout the State is handled in this form and calculations are made in bags and not in bushels. There is therefore no use for the grain elevator, in the ordinary sense of the term. Each bag contains 2½ bushels or about 150 pounds.

West of the Cascades, in Oregon, conditions are somewhat similar to those in California. In a large portion of the State a considerable amount of spring wheat is grown. In addition to the ordinary club wheats some other varieties, such as Oregon Red Chaff and Foise, are also well represented. The midsummer climate is much cooler than in California, and therefore harvesting is performed much later. On account

of the greater dampness of the atmosphere and the smaller size of the farms combined harvester-threshers are not used, but self-binders instead. There is great need of early maturing varieties, as the cool autumn weather begins so early. The nitrogen content of the grain is exceedingly small.

In eastern Oregon climatic and other conditions are quite different from those west of the Cascades, and a description of that section is more properly included in the discussion of the Palouse country.

In western Washington the general conditions and the quality of the wheat are very similar to those of western Oregon, but in southeastern Washington and adjacent portions of Idaho and Oregon is a large section known as the Palouse country, which possesses peculiarities of soil and climate that are distinctively characteristic and radically different from those of the Pacific Coast region proper. Strictly speaking, the Palouse country is considered to be rather limited in extent, comprising approximately Latah County, Idaho, and Whitman County, and very small adjoining portions of Adams and Franklin counties, in Washington. Recently, however, the term has come to be applied practically to nearly all of these last-named counties, as well as to Garfield, Columbia, and Walla Walla counties (Plate V), and may even include the northern portion of Umatilla County, Oreg. The two features which most distinguish this region from the Pacific Coast proper are the dryness of the climate and very finely divided condition of the soil. The particles are so very fine that when dry the soil is practically mere dust. On windy days this dust fills the air, forming vast clouds that are very disagreeable to the traveler. At the same time, with very little rain the soil becomes quite sticky and difficult to manage. The capacity of the soil to absorb and retain moisture is remarkable. It is pretty generally believed that a rainfall of 12 inches in this district is sufficient to make a crop of wheat, while in the States of the Plains 18 inches is considered to be rather low for successful wheat growing. Wheat is the chief crop of the region, though barley and oats are grown to some extent. The principal wheat varieties (except Palouse Blue Stem) are of the club-wheat group. They are usually soft grained and starchy, and generally white, similar to those of the coast region, but a little better in quality. The three standard varieties commonly grown are Palouse Blue Stem, Palouse Red Chaff, and Little Club. As regards the comparative distribution of these varieties, if the region be considered as divided into three parallel north and south belts, it will be found that Palouse Blue Stem prevails in the western belt, extending as far westward as North Yakima; Palouse Red Chaff in the middle belt, passing through the heart of the region, and Little Club in the eastern belt, reaching the foothills of the mountains.

The most serious obstacle to successful wheat culture in the Palouse country is the annually recurring drought which occurs about two weeks before harvest time, particularly in the western and southern

FIG. 1.—HARVESTING WITH THE COMBINED HARVESTER-THRESHER NEAR WALLA WALLA, WASH. (PHOTOGRAPHED BY A. B. LECKENBY.)

FIG. 2.—WHEAT FIELDS BEFORE AND AFTER HARVESTING, NEAR WALLA WALLA, WASH (PHOTOGRAPHED BY A. B. LECKENBY.)

portions. From this cause the wheat is often badly shriveled, and both the yield and quality thereby much affected. A slight compensation for this loss lies in the fact that shriveled wheat in this district is more in demand for making macaroni than plump wheat, because of the greater proportional amount of gluten in the former. In order to escape the severe effects of the drought, early maturing sorts are exceedingly desirable. It would probably be no exaggeration to say that a variety ripening ten to fifteen days earlier than the varieties now used, and as good in other respects, would add from one to three million dollars a year to the wealth of this region. In the central and southern portions of the region fall sowing is chiefly practiced, but in the northern and eastern portions, near the mountains, there is a larger proportion of spring varieties, and there a good, hardy winter sort is needed. In the drier western and southern portions, especially in the vicinity of Walla Walla, nonshattering varieties are necessary. There the combined harvester-thresher (Plate VI, fig. 1) is used in harvesting, as in California. In the north and east, and in the more hilly portions, as in the vicinity of Colfax, the self-binder is more commonly employed. In a few places a comparatively new sort of machine has recently come into use. (Plate VI, fig. 2.) It makes a 10 or 12 foot cut, and is driven in front of the horses, as in the case of a header, but unlike the latter possesses a self-binding attachment as well.

SUMMARY OF CONDITIONS AND NEEDS OF THE DISTRICT.

(1) Principal varieties at present grown:

Australian,	Palouse Blue Stem,
California Club,	Palouse Red Chaff,
Sonora,	Little Club,*
Oregon Red Chaff,	White Winter,

Foise.

(2) Average yield per acre, about $14\frac{7}{8}$ bushels.

(3) Needs of the grower:

(*a*) Early maturity.

(*b*) Nonshattering varieties.

(*c*) Hardy winter varieties in the colder portions.

SOURCES FOR DESIRABLE QUALITIES.

Having described the characteristic features of the different wheat districts of the country, and having noted the most pressing needs of the grower in each one, respectively, it will now be appropriate to discuss the sources from which the desirable qualities may be obtained for satisfying these needs. This subject may be considered from two different standpoints, (1) the botanical subdivisions of the cultivated varieties of wheat (*Triticum*) in the broadest sense, and (2) the geographic groups of varieties characteristic of different regions of the

world. Manifestly a complete treatment of the subject can not be presented in the present state of our knowledge, since wheat varieties and their adaptations have not been thoroughly studied in all parts of the world. Nevertheless, considerable investigation has been made in this line, and the future promises still more. Such studies are exceedingly interesting, and form an absolutely necessary part of the basis for rational wheat improvement.

CHARACTERISTICS OF BOTANIC GROUPS OF WHEAT.

The cultivated varieties of *Triticum*, according to Körnicke and Werner,[1] whose classification will in the main be followed in this bulletin, may be grouped into eight species and subspecies, as follows: *Triticum vulgare*, *T. compactum*, *T. durum*, *T. turgidum*, *T. polonicum*, *T. spelta*, *T. dicoccum*, and *T. monococcum*. Only *T. vulgare*, *T. polonicum*, and *T. monococcum* are considered to be good species in all classifications. The other five are generally considered as subspecies of *T. vulgare*, though *T. compactum* is sometimes not even elevated to that rank. In this bulletin they will all be referred to as though they were distinct species. The chief characters of these groups of wheats will now be described, with special reference to their importance in wheat improvement.

COMMON BREAD WHEATS (*Triticum vulgare*).

This is of course the most valuable and widely distributed group of wheats in the world, and is represented by a greater number of varieties than all other species taken together. Nevertheless a number of very important qualities can be found only among varieties of the other species.

The characters of this group, both botanical and agricultural, are well known. The heads are long in proportion to thickness, as compared with those of some other groups. They are broader in the plane of the rows of spikelets, as a rule, and narrower on the sides of the furrow between the rows; taper toward the apex, but may be very blunt or even thicker above; are usually loosely formed comparatively, bearded or bald, and usually possess smooth chaff, but may be velvety. The spikelets, or meshes, as they are popularly called, generally contain three grains, but sometimes two and rarely four. The empty glumes or outer chaff of the spikelets are slightly keeled above and merely arched below. The stem of the plant is usually hollow, but occasionally somewhat pithy within and varies greatly in strength and height in different varieties. The leaves also vary in character, but are rarely as wide as those of the durum and poulard groups, and are velvety in only a few varieties.

[1] Körnicke, Fr., und Werner, H. Handbuch des Getreidebaues. 1885.

The species is usually divided into a number of botanical subspecies and varieties, based upon the presence or absence of beards, nature and color of the chaff, color and quality of the grain, etc. For our present purpose, however, it will be more useful to consider that there are five great subdivisions of the species, based not upon botanical characters, but upon characteristics induced by influences of environment, as follows: (1) Soft Winter wheats, (2) Hard Winter wheats, (3) Hard Spring wheats, (4) White wheats, and (5) Early wheats.

The location of these groups in the United States has already been pretty well stated in the descriptions of our wheat districts. Their distribution throughout the world is approximately as follows: (1) The soft winter wheats, varying in color of grain from amber to white, are produced under the influences of considerable moisture and mild, even temperatures, and are distributed in the Eastern United States, western and northern Europe, Japan, and in portions of China, India, Australia, and Argentina. (2) The hard winter wheats are red-grained, usually bearded, possess a relatively high gluten content, and are more limited in their distribution. They are grown usually on black soils and under the influences of a climate characterized by extremes of temperature and moisture, but especially by dry, hot summers. They are found chiefly in the States of Kansas, Nebraska, Iowa, Missouri, and Oklahoma in this country, in Hungary and Roumania, in southern and southwestern Russia, and to some extent in northern India, Asiatic Turkey, and Persia. (3) The hard spring wheats are also red-grained and rich in gluten content, and are adapted to conditions of soil and climate identical with those just mentioned for hard winter wheats, with the exception that the growing season is shorter and the winters too severe for winter varieties. They are found in central and western Canada, our Northern States of the plains, east Russia, and western and southern Siberia. (4) The white wheats are soft and very starchy, but possess grains a little harder and much drier than those of the soft winter wheats. They are either fall or spring sown, and are sometimes sown at both seasons in the same locality. They are grown chiefly in the Pacific coast and Rocky Mountain States of this country, in Australia, and in Chile, Turkestan, and the Caucasus. (5) The early wheats are soft or semihard and generally amber to red in color of grain, but are distinguished from other groups chiefly in their ability to ripen early. They are found in Australia and India, are represented by a very few varieties in the Southern States of this country, and include some of the dwarf wheats of Japan.

The varieties of this species naturally include the most diverse characters, because of their cultivation under so many diverse conditions. Their greatest characteristic as a whole, however, is, of course, the well-known and long-established quality of their grain for the produc-

tion of bread flour, for which reason the term "bread wheat" is usually applied to them. Nevertheless, it should be noted that the difference between the best and poorest sorts of this group for bread making is fully as great and sometimes greater than between the former and some varieties of other groups. The hard, red-grained varieties are by far the best both in food content and for our present system of roller milling. They include the Fifes, Velvet Blue Stem, Turkey, Mediterranean, and Fulcaster, of this country and Canada; the Ghirkas, Ulka, Crimean, and Buivola, of Russia; and the Theiss and Banat, of Hungary and Roumania. On the other hand, the white wheats and soft winter wheats give the best success in the manufacture of crackers. Several of the most popular breakfast foods are also made from white wheats. In a few instances macaroni is made from the hard spring wheats and the white wheats, but not extensively. No varieties of the bread-wheat group are well adapted for this purpose.

The special qualities that are found in varieties of this group may be summarized as follows:

(1) Excellence of gluten content for bread making.
(2) Excellence of certain varieties for cracker making.
(3) Yielding power of certain sorts.
(4) Rust resistance in some varieties.
(5) Hardy winter varieties.
(6) Resistance to drought (in some varieties).
(7) Early maturity (in some varieties).

CLUB OR SQUARE HEAD WHEATS (*T. compactum*).

By most writers this is not even ranked as a subspecies, but the different varieties certainly form an isolated group which is quite complete in itself and distinct from all other wheats, and which will therefore be considered here as a distinct species. The various varieties are commonly known under the names "club" or "square head". In this species the plant is very erect, with stiff, usually rather short, culm, attaining an average height of probably little more than 2 feet. The heads are extremely short as a rule, and often squarely formed, in some varieties much broader and flattened on the furrow side, usually thicker at the apex than at the base, commonly white but sometimes red, bearded or bald, the bearded varieties usually being native in hot countries. The spikelets are set extremely close together, often standing almost at right angles to the rachis (stem), three or four-grained, sometimes with four grains nearly throughout the entire head. The outer and inner chaff are much the same as in the bread wheats. The grains are usually short and rather small, white or red, often boat-shaped, and occasionally appear much like those of naked barley.

The peculiar structure of the head in this species allows the varieties to be comparatively large yielders, which is naturally their most

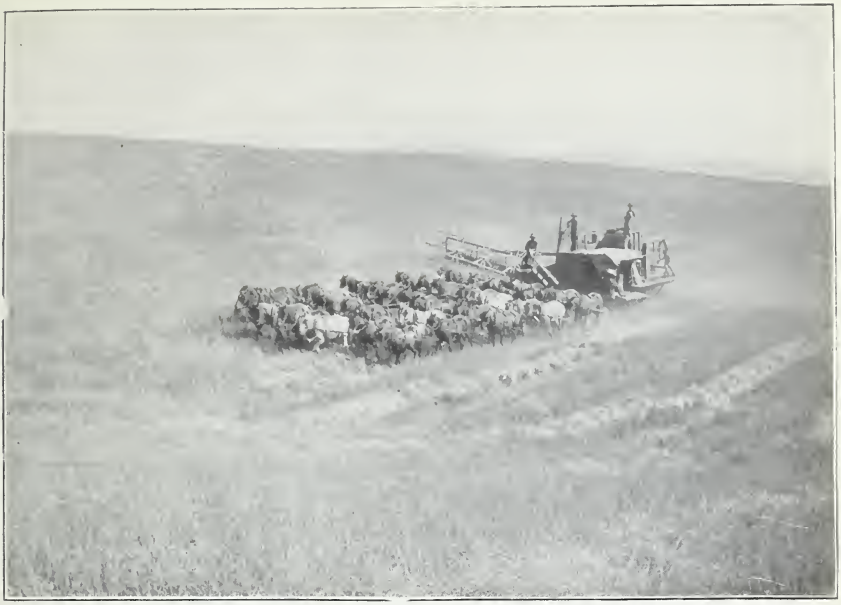


FIG. 1.—COMBINED HARVESTER-THRESHER AT WORK NEAR WALLA WALLA, WASH. (PHOTOGRAPHED BY A. B. LECKENBY.)

FIG. 2.—HARVESTING WITH THE WIDE-CUT BINDER NEAR COLFAX, WASH. (ORIGINAL.)

important quality. They are very deceptive in this regard, the shortness of the head leading one to suppose at first that it can not contain so many grains as are present in reality. The chaff is usually very tenacious, so that these wheats may be harvested long after ripening without loss from shattering. This is especially true of varieties grown in California and Washington. Having short, stiff straw, these wheats also usually stand up well, any damage from lodging being quite rare among them. Besides producing the class of flours desired in certain localities, club varieties are very good for cracker making and for the more starchy kinds of breakfast foods. They are grown either as spring or winter varieties except in Turkestan, where the winters are too cold for fall sowing. Being grown in dry, hot regions, they are usually rather drought resistant.

Club wheats are at present cultivated chiefly in the Pacific Coast and Rocky Mountain States of this country, in Chile, Turkestan, and Abyssinia, and to a slight extent in Switzerland, Russia, and a few other districts of Europe. The special qualities of the group are as follows:

(1) Great yielding power.
(2) Stiffness of straw.
(3) Freedom from shattering.
(4) Early maturity (in some varieties).
(5) Drought resistance (in some varieties).
(6) Excellence of certain varieties for cracker making and breakfast foods.

POULARD WHEATS (*T. turgidum*).

This group of wheats is usually classed as being quite distinct from the durum (*T. durum*) group, the two ranking as subspecies of *T. vulgare*. But as a matter of fact there are intergrading varieties which bring them as close together as are the club wheats and common bread wheats. They will both be considered here, like *T. compactum*, as distinct species.

The poulard wheats are usually rather tall, with broad, in most varieties velvety, hairy, or often glaucous leaves. The stems are thick and stiff, and sometimes pithy within. Heads long, often squarely shaped, with long beards, that are white, red, or bluish red in color, or sometimes black. Spikelets two to four-grained, and arranged rather compactly. Outer chaff strongly and sharply keeled. Grains large, proportionally short and rounded, sometimes almost semicircular in middle cross section, rather hard and glutinous, light yellowish red in color, sometimes nearly white, and becoming glassy in varieties allied to the durum group, or on growing in certain soils.

The name poulard is most commonly applied to these wheats. In Europe they are sometimes called English wheats, a very misleading name, as they are really little grown in England. On the other hand the few varieties that have been grown there are known as rivet

wheats. A name often used in Germany is *bauchiger Weizen*, and a French name of corresponding meaning occasionally used is *blé petanielle.*

The wheats of this group are used sometimes in the manufacture of macaroni and other pastes. They are also occasionally used in bread making, but are more often employed for mixing with common bread wheats in grinding in order to give the quality of flour that is desired in the French markets.

To a small section of this species, having compound or branched heads, some have given the separate name of composite wheats (*T. compositum*). Some well-known varieties of this section are Seven-headed, Wonder Wheat, Hundred Fold, and Miracle. It should be noted, however, that the group of emmers (*T. dicoccum*) includes several varieties with compound heads similar to these. Many facts known in connection with the existence of these closely allied forms, together with that of the intergrading sorts between the poulards and durums, afford strong evidence of the occurrence of natural hybrids among the varieties of these three groups.

The poulard wheats are native usually in hot, dry regions, and are therefore often rather drought resistant, but not so much so probably as the durums. Many of the varieties are also very resistant to orange leaf rust. These wheats are grown chiefly in France, Egypt, Italy, Turkey, Greece, southern Russia, and other districts bordering the Mediterranean and Black seas. In this country they are only rarely grown; so far, in an experimental way. Special qualities of value to be found in this group are:

(1) Excellence of certain varieties for making macaroni.
(2) Resistance to orange leaf rust.
(3) Resistance to drought.
(4) Stiffness of straw.

DURUM WHEATS (*T. durum*).

As already stated, this group of wheats is rather similar to the poulard group. As a rule, however, the heads are not so thick and the grains are longer and much harder. The plants are rather tall, with stems either pithy within, or hollow with an inner wall of pith, or in a few varieties simply hollow as in the common bread wheats. The leaves are usually smooth, but have a hard cuticle, and are almost always resistant to orange leaf rust. The heads are rather slender, compactly formed, occasionally very short, and always bearded, with the longest beards known among wheats; spikelets two to four-grained. The outer chaff is prominently and sharply keeled, and the inner chaff somewhat compressed and narrowly arched in the back. The grains are usually very hard and glassy, sometimes rather transparent, yellowish white in color, occasionally inclining to reddish, and

proportionally rather long. In the variety Arnautka the grains are almost or fully as large as those of Polish wheat, and are sometimes actually mistaken for the latter.

The varieties of this group are generally best known as the durums. In Europe they are often called, and correctly so, simply hard wheats. They are the hardest-grained wheats that are known. The Fifes, Velvet Blue Stem, Turkey, and others of that class usually called hard wheats in this country are not, strictly speaking, hard wheats at all when compared with these. On account of the resemblance of the heads of these wheats to those of barley they are sometimes called barley wheats or *Gerstenweizen*.

Durum wheats are particularly sensitive to changes of environment, and quickly deteriorate when grown in a soil or climate to which they are not well adapted. Such a change of conditions may be encountered, too, within the distance of a few miles. For example, it is well understood in south Russia that the excellent variety Arnautka gives the best results only when grown within a very limited area bordering the Sea of Azov. So also the best Kubanka is found east of the Volga on the border of the Kirghiz Steppes. In the Caucasus this variety has actually developed into a red winter wheat, though the original is a yellowish-white spring wheat.

The durum group furnishes the great bulk of the world's supply of macaroni wheat, though a considerable amount of these pastes is made from poulard and Polish varieties and a still smaller proportion from the common bread wheats. There is now not the least doubt that some if not all these durum sorts used for macaroni can be successfully grown in this country, thus adding immensely to the profits of our wheat industry. The success that has attended the trials of the variety Nicaragua in Texas has already conclusively proved the point. At the same time the idea that these wheats can not be successfully used for bread has never yet been shown to be more than mere assumption. Several mills in this country have successfully ground them, and in southern Russia, where milling has developed to a high degree of perfection, it is no longer an experiment. In that region durum wheat has become actually the most popular for bread making, though it is usually mixed with a small per cent of ordinary red wheat before grinding. In France there is an increasing demand for durum wheats for all purposes.

Durum wheats are adapted for soils rather rich in nitrogenous matter but somewhat alkaline, and give the best results in a very hot, dry climate. They are, therefore, quite drought resistant. Almost all varieties are adapted only for spring growing except in mild latitudes. The young plants both of this group and the poulard group are very light green in color at first and grow up rapidly. They are grown in Spain (where they predominate over all other groups) and other Mediterranean countries, in south and east Russia, Asia Minor,

and to some extent in Mexico, Chile, and Argentina. In this country one variety, Nicaragua, is grown to a limited extent, chiefly in Texas.

The special qualities to be obtained in this group are briefly:

(1) Excellence of gluten content for making macaroni and other pastes.
(2) Resistance to drought.
(3) Resistance to orange leaf rust.

POLISH WHEATS (*T. polonicum*).

This group is considered by all writers to belong to a distinct species. Though there are several subspecies and varieties, apparently only one variety, White Polish, is very widely known. The plant is usually rather tall, with stems smooth and more or less pithy within. It does not stool extensively. The heads are extremely large and loosely formed, and before ripening are bluish-green in color. A special peculiarity of this species is the rather long, narrow, outer chaff, papery in structure, and standing out slightly from the head, instead of being rigid and closely applied to the spikelets, as in other wheats. The grains are of great size when normal, proportionately quite long, yellowish-white in color, and very hard. The name Polish wheat is universally applied to this species, though for what reason it is not clear. There is no evidence at all that it originated in Poland, and in fact it has been very little grown in that region. It is more probable that its native home is some portion of the Mediterranean region. A red winter wheat grown rather extensively in Poland and southwest Russia and also called Polish wheat, should not be confused with this group, as it is radically different, being one of the bread wheats. Other names have been given to this species but they are quite local in their use; such are Giant rye, Astrakhan wheat, Jerusalem rye, etc.

In almost all of the few cases where Polish wheat has been tried in this country it has proved a success from both the standpoint of yield and quality of the grain. But it seems never to have occurred to anyone to make use of the wheat for the production of American macaroni, though no doubt it would be excellent for that purpose, and a great demand for its increased production could thus be created. As it is, there is not sufficient incentive to the farmer for growing this wheat, since it is not well adapted for bread making if used alone.

Though requiring considerable moisture at seed time, Polish wheat is admirably adapted for cultivation in arid districts; in fact, it produces the best quality of grain when grown under arid conditions. It is also somewhat resistant to orange leaf rust, but not so valuable in this respect as the durum wheats. Varieties of this species are grown chiefly in Italy, Spain, and other portions of the Mediterranean region, and in southern Russia and Turkestan. They are also said to be cultivated to some extent in Brazil.

The special qualities of value belonging to Polish wheat are similar to those of the durum group, and are as follows:

(1) Quality of gluten content for making macaroni.
(2) Resistance to drought.
(3) Resistance to orange leaf rust.

SPELT (*T. spelta*).

This and the two following species are in several respects very different from any of the preceding groups. They are also not widely cultivated, although more commonly grown than Polish wheat, and are used only to a very limited extent for human food. Nevertheless, in the intercrossing of wheat groups for the improvement of our bread wheats some very valuable qualities may be obtained from varieties of these species.

The varieties of this group are called spelt in English, *Spelz* in German, and *épeautre* in French. In Germany the old name *Dinkel* is also sometimes applied. The varieties often called spelt in this country and Russia are not spelt, but emmer (*T. dicoccum*).

The spelt plant (Plate VII) grows to the average height of wheat, or perhaps a little higher, and possesses a hollow stem. The leaves are of ordinary size, usually smooth, but sometimes with scattering hairs; heads loose, narrow, and rather long, bearded or bald, especially characterized by a very brittle rachis, allowing them to be easily broken in pieces in thrashing. The spikelets are usually far apart in the head, arched on the inner side, and contain usually two grains; outer chaff oval, four-angled, boat-shaped, and only slightly keeled; grains light red in color, somewhat compressed at the sides, with a narrow furrow, the walls of the furrow flattened, and with sharp edges. The grain is always held tightly within the chaff, and can not be hulled in thrashing.

Spelt is used very little for human food, but is generally fed to stock. It is very important, however, for certain portions of our country, at least, to obtain for the bread wheats the particular quality of this group of holding the grain tenaciously. This can readily be done, as the Garton Brothers have amply demonstrated in England, by intercrossing varieties of the two groups. For certain varieties that would otherwise be of great value in the Pacific Coast and Rocky Mountain States such an improvement of preventing shattering at harvest is the most important that can be made. The few varieties possessing this quality that are now grown in these districts are sometimes not desirable in other respects. At the same time complaint is often made that certain introduced varieties which are most excellent from the standpoint of yielding capacity and hardiness are rendered worthless because of the great loss from shattering. It has also been observed by certain experimenters that the quality of constant fertility, or of producing

"well-filled" heads, is greatly increased by the introduction of the spelt element. No doubt we very little realize the loss in yield that is simply the result of the inability of the variety to fill out its heads.

There are both winter and spring varieties of spelt, and some of the former are very hardy. Certain varieties are also rather drought resistant, but nearly all sorts are more or less susceptible to rust attacks. It is in just such cases as that of the use of spelt varieties in intercrossing with bread wheats that the greatest of judgment must be exercised because of the presence of undesirable as well as desirable qualities. While the experimenter is endeavoring to secure the qualities of nonshattering, drought resistance, etc., it is equally important to select from the progeny of such crosses in such a way as to eliminate the characteristics of rust liability and brittleness of the head. Here also is shown emphatically the advantage of the practice of composite crossing (to be discussed further on), as in such case the variation induced is so great that there are almost certain to be individuals present among the sporting offspring which possess the desired qualities without having preserved the undesirable ones.

Spelt is chiefly grown in Germany, Italy, Spain, France, and Switzerland, and perhaps to a small extent in Brazil. It is not grown in this country except mainly in an experimental way. Summarized, the desirable qualities found in the spelt group are:

(1) Power of holding the grain in the head.
(2) Constancy in fertility.
(3) Hardiness of certain winter varieties.

The undesirable ones are:

(1) Brittleness of the head.
(2) Rust liability.

EMMER (*T. dicoccum*).

This species has no English name, but is often incorrectly called spelt in this country. The German name is *Emmer* and the French *amidonnier*. As the German name is best known and easily pronounced, it should be at once adopted with us, and the name spelt applied where it properly belongs. In Russia, where the group is well represented, it goes by the name of *polba*, which name is invariably translated spelt. But either the Russians wrongly apply the name polba or this is an incorrect translation. As a matter of fact, very little if any true spelt is grown in Russia, though a rather large quantity of emmer is produced each year.

The plants of this species are pithy or hollow, with an inner wall of pith; leaves sometimes rather broad, and usually velvety hairy; heads almost always bearded, very compact, and much flattened on the two-rowed sides. The appearance in the field is therefore quite different from that of spelt. The spikelets (that is, the unhulled grains as they

SPELTS AND EINKORNS IN EXPERIMENTAL PLATS AT GARRETT PARK, MD.: 1, SPELTS; 2, EINKORN; 3, ENGRAIN DOUBLE; 4, SPELTS. (ORIGINAL.)

come from the thresher), however, look considerably like those of spelt, but differ principally in the presence always of a short pointed pedicel. This pedicel, which is really a portion of the rachis (stem) of the head, if attached at all to the spelt spikelets, is always very blunt and much thicker. Besides, the emmer spikelets are flattened on the inner side, and not arched as in spelt, so that they do not stand out from the rachis as the spelt spikelets do, but lie close to it and to each other, forming a solidly compact head. The spikelets are usually two-grained, one grain being located a little higher than the other. The outer chaff is boat-shaped, keeled, and toothed at the apex. The grain is somewhat similar to that of spelt, but is usually harder, more compressed at the sides, and redder in color.

For the production of new varieties by hybridization emmer has qualities similar to those of spelt, but still more valuable. At the same time emmer, besides possessing harder grain, is more resistant to drought, and usually rather resistant to orange leaf rust. It is well adapted for cultivation in the northern States of the Plains and has already proved very valuable as a hardy forage plant in that region, besides giving a good yield of grain per acre. Almost all varieties are spring grown. Of other countries emmer is chiefly cultivated in Russia, Germany, Spain, Italy, and Servia, and to some extent in France. The emmer of this country is descended from seed originally obtained chiefly from Russia, where a considerable portion of the food of the peasants of the Volga region is a sort of gruel ("kasha") made from hulled and cracked emmer.

The desirable qualities furnished by this group of wheats are:

(1) Power of holding the grain in the head.
(2) Drought resistance.
(3) Resistance to orange leaf rust.

The undesirable qualities are:

(1) Brittleness of the head.
(2) Adaptability only for spring sowing.

EINKORN (*T. monococcum*).

This species of wheat is very distinct from any of the others, though the heads resemble those of emmer somewhat. It has no English name, but is called *Einkorn* in German and *engrain* in French. The German name is adopted here.

Einkorn (Plate VII) is a short, thin, and narrow-leaved plant, which presents a peculiar appearance in the field. It seldom reaches a height of more than 3 feet. The stem is hollow, thin, and very stiff. The leaves are usually quite narrow, sometimes hairy. Those of the young plant are sometimes bluish-green, and after flowering the plant becomes yellowish-green. Portions of the stem may also be brown. The heads are slender, narrow, very compact, bearded, and much flattened

on the two-rowed sides, and always stand erect, even when ripe, but break in pieces easily. The spikelets are flat on the inner side, or form a concave surface with the projecting edges of the outer chaff. They are arranged very compactly in the head and are usually one-grained, except in the variety Engrain double (Plate VII), where they possess two grains. The outer chaff is deeply boat-shaped and rather sharply keeled, the keel terminating in a stiff tooth. The grains, which are tightly inclosed in the spikelet, are light red and extremely flattened, becoming thus bluntly two-edged and possessing an exceedingly narrow furrow.

This species is at present but little improved over the original wild form, and only a few varieties have been developed. Nevertheless some of the most valuable qualities may be expected from these varieties if they can be successfully employed in hybridization experiments. They are among the hardiest of all cereals and seem to be constant in fertility, and in the writer's experience are absolutely proof against orange leaf rust. Einkorn is entirely unknown in this country, except among a few experimenters, but is grown to a limited extent in Spain, France, Germany, Switzerland, and Italy. The two chief varieties are common Einkorn and Engrain double.

The valuable qualities to be obtained in this species may be summarized as follows:

(1) Power of holding the grain in the head.
(2) Resistance to orange leaf rust.
(3) Hardiness.
(4) Resistance to drought.
(5) Stiffness of straw.

An undesirable quality is:

(1) Brittleness of the head.

GEOGRAPHIC GROUPS OF WHEATS.

From the description of the different natural groups just given and the statements concerning their geographic distribution, it may be inferred that the localities as well as the natural groups might also be given from which particular qualities in wheat can be obtained. This can be done, but not with the completeness that could be desired, as it is not yet accurately known what kinds of wheat grow in all regions of the world. However, the matter may be stated approximately and briefly as follows: (1) White wheats containing much starch are grown in the Pacific Coast and Rocky Mountain States of this country, in Chile, in Turkestan, and to some extent in Australia and India. (2) Amber or reddish-grained wheats, also starchy, are to be found chiefly in the Eastern States of this country, in western and northern Europe, and to some extent in India, Japan, and Australia. (3) Large proportions of gluten content of the quality considered to

be necessary for making the best bread are found in the red wheats of Canada and our Northern and Middle States of the Plains, in eastern and southern Russia, in Hungary and Roumania, and in southern Argentina. (4) Resistance to orange leaf rust is to be secured in the bread wheats of southern Russia (particularly in the Crimea and Stavropol government), in the poulards, emmers, and einkorn of the countries bordering the Mediterranean and Black seas, and in a few varieties in Australia. (5) Large gluten content of the quality necessary for making the best macaroni is furnished by the durums, poulards, and Polish wheat of Algeria, Italy, Spain, and especially of the northern shores of the Black and Azov seas in Russia, and to a limited extent in the State of Texas in this country. (6) Stiffness of straw, preventing the lodging of the grain, is found in the einkorn and some of the spelts, durums, and poulards of the Mediterranean countries, and in the dwarf bread wheats of Japan, and some of the club wheats of our Pacific Coast States, Turkestan, and Australia. (7) Great yielding power, at least in proportion to the length of the head, is obtained in the club wheats of the Pacific Coast States of this country and Chile, and Turkestan. (8) The quality of holding the grain, or nonshattering, is found in the club wheats of the Pacific Coast States, Chile, and Turkestan, and in all the spelts, emmers, and einkorn of east Russia, Germany, and the Mediterranean countries, and to a limited extent in the emmers of our northern States of the Plains. (9) Constant fertility, so far as known at present, is probably best obtained in the spelts of Germany and Southern Europe. (10) Early maturity is found to a limited extent in some of the bread wheat varieties of Australia and India, and in the dwarf wheats of Japan. (11) Resistance to drought and heat is best secured in the common red wheats and durums of south and east Russia, and the Kirghiz Steppes, the durums of the south Mediterrean shore, and both the bread wheats and durums of Turkestan. (12) Resistance to drought and cold is found to the greatest degree in the red winter wheats of East Russia.

IMPROVEMENTS ACCOMPLISHED.

Looking to the future, the possibilities for wheat improvement appear to be unlimited, and it is with these that we are of course more directly concerned at present. It will be of interest, however, to consider briefly some of the great changes for the better that have already been made in the wheat industry of this country during its short history. Some of these changes have been accomplished in line with similar ones in other countries, and have been coincident with improvements in the milling process or with the demands of consumers for greater variety in food, but in the main they have followed as a natural result of the development of the country. As wheat is not native

in the United States, necessarily all seed was originally brought from other regions. At first, the territory being limited and the demands of the people comparatively simple, very few varieties were sufficient; but as the country rapidly developed and new territory was from time to time added and thrown open to settlement, new and varied conditions of soil and climate were encountered, and to meet the requirements of these new conditions other new and different varieties became necessary in order for the best success.

INTRODUCTION OF NEW VARIETIES.

A full history of the introduction of new varieties of wheat into this country, and from one section of the country to another, would be a matter of much interest but can not be attempted here. Only a few of the most important instances will be mentioned—those that mark real epochs in the development of our wheat industry, and have in certain localities entirely revolutionized wheat culture.

By far the most important among the earliest varieties introduced is the Mediterranean wheat, obtained first in 1819 from the islands of the Mediterranean Sea. At various times after that date this Department secured seed of the same variety and distributed it to all parts of the country. It soon met with favor everywhere. It is a hardy, bearded variety, productive, and producing a large red grain of good milling quality. But more than all this it was found to be quite resistant to rust and to damage by the Hessian fly, two enemies of the wheat crop which had already begun to be very much dreaded. This wheat has maintained its excellence through all decades since, and is to-day one of the most popular varieties in certain States, particularly Texas. It has also been used as a parent of several very valuable hybrids.

A most interesting example of improvements that are possible in the adoption of varieties best adapted to a particular region is found in the Fife wheats of Canada and the Northern States of the Plains. These varieties, which have become the basis of the great wheat and flour production of the Northwest, originated, according to the Canadian Agriculturist of 1891, in the following manner:

> Mr. David Fife, of the township of Otonabee, Canada West, now Ontario, procured through a friend in Glasgow, Scotland, a quantity of wheat which had been obtained from a cargo direct from Dantzic. As it came to hand just before spring seed time, and not knowing whether it was a fall or spring variety, Mr. Fife concluded to sow a part of it that spring and wait for the result. It proved to be a fall wheat as it never ripened, except three ears, which grew apparently from a single grain. These were preserved, and although sown the next year under very unfavorable circumstances, being quite late and in a shady place, it proved at harvest to be entirely free from rust when all wheat in the neighborhood was badly rusted. The produce of this was carefully preserved, and from it sprang the variety of wheat known over Canada and the Northern States by the different names of Fife, Scotch, and Glasgow.

If the above is an accurate statement of the introduction of Fife wheats, indications are rather strong that they are of Russian origin,

judging from the description of the grain and source of the cargo, in connection with the present similarity of these wheats to Russian varieties. Their subsequent history in the Northwest and the impetus given to the wheat industry of that region through their cultivation are well known to agriculturists generally. Various strains have been developed till there are now a dozen or more so-called varieties in use. They are red, hard-grained wheats (as we use the term) similar to the Ghirkas of the Volga region, yield fairly well, and produce flour of excellent quality.

In Michigan there has been an energetic movement for a decade or longer to obtain hardy winter sorts, which has resulted in a great improvement not only for that State but for adjoining territory. The millers of the State have especially been active in this movement and the matter has been frequently a prominent topic of discussion at the meetings of the State Millers' Association. Budapest from Hungary and Dawson's Golden Chaff from Canada have been introduced and become favorite varieties. Another variety, Theiss, introduced from Hungary, has obtained a well-merited reputation as a hardy, red winter sort in the North Central States and as far west as Kansas. It has, however, not even yet received the attention that it should have.

Perhaps the most remarkable development in wheat culture in this country has been made in the Middle States of the Plains, in what we may now call the Hard Winter Wheat district, all brought about through the introduction of the hardy, red-grained wheats. Twenty-five years ago very little hard wheat was grown in this region, the seed being brought by the early settlers from States farther east, where soft wheats were chiefly cultivated. Also, spring varieties formed the basis of a large proportion of the wheat production. But the spring wheats were severely rusted, injured by drought because of late maturity, and in some seasons almost wholly destroyed by chinch bugs, while the soft winter sorts, such as White Michigan and Poole, also rusted badly and were not able always to stand the winters. For some time these defects were overcome in great measure by the use of the variety Odessa, popularly called "Grass" wheat in some localities, which is probably equivalent to the variety Ulka of southern Russia. It is hardy, red-grained, rather rust resistant, and has the additional advantage of being adapted for either autumn or spring sowing. A little later, the well-known variety Fultz also became quite popular in the West, as it is still in the greater portion of the United States.

But the variety which more than all others finally completely changed the status of wheat culture in this district, is that which is commonly but unfortunately known as Turkey. It is a bearded, hard red wheat of the highest class, coming originally from the Crimea and other portions of Taurida in southern Russia, and not from Turkey as the name would imply. Within a very small area in Kansas, Turkey wheat has been grown about twenty-five years, but its merits have

become generally known only during the last twelve or fifteen years. It is now a favorite variety in the middle Great Plains. By the use of this variety autumn sowing is now made practicable in most seasons to the northern limit of the district, and the winter-wheat flour from this region has obtained a reputation for quality of the very best, and distinctively its own, in the foreign markets. At the same time there is no longer so much damage resulting from the attacks of rust and chinch bugs. As it is also one of the most drought-resistant sorts, it has made it possible to extend the winter-wheat area farther westward as well as northward.

In a large part of the Pacific coast region, including the Palouse country, the improvements which have resulted in such large yields and great profit in certain localities were made chiefly through the introduction of club wheats, which are very productive, hold the grain in the head, and are in other regards well adapted to the conditions of the region. One or more of these wheats came originally from Chile, and others probably from Australia and France, but the origin of many of them is not accurately known. Two other varieties, not club wheats, namely, Australian and the Palouse Blue Stem, are also two of the most valuable wheats of this district and probably belong to the Purple Straw group of Australia.

In southern California and the Irrigated Wheat district the variety Sonora has had the greatest influence in the development of wheat culture. It is a white-grained sort with reddish, velvet chaff, but the grains are a little harder than those of the club type and better adapted for export. It came originally from the State of Sonora in Mexico.

Among later introductions is the variety called Nicaragua, a durum wheat, already discussed in another part of this bulletin, which is likely to take a considerable part in the future wheat production of this country, both because of its adaptation—as is true of all durum varieties—to the hot, dry summers of the southwestern Great Plains, and because of its suitability for the manufacture of macaroni. No facts concerning the origin of this variety are at present known to the writer, though one would infer from the name that it came from Nicaragua, and it is true that varieties of the same group are known in that country. It has been known in Texas for many years, and its use has made it possible to grow wheat in portions of that State not before successful in wheat growing. A variety similar to this one, called Wild Goose, is grown to a very limited extent in North Dakota, and probably came originally from southern Russia. It is also likely to be of value for the production of macaroni, though it seems to be somewhat inferior to Nicaragua.

WORK OF THE DEPARTMENT.

In connection with the discussion of the introduction of varieties, it is hoped that it will be of interest to give an account of the experiments made by this Department with wheats from all parts of the world. Though the aim in beginning these experiments, as already

stated, was primarily to test rust resistance, the work naturally soon developed into a study of the characteristics in general of the varieties of different natural groups of wheats, and of groups considered geographically, and some most interesting facts were thus obtained which will be of great value in the work of wheat improvement. In fact, many statements made in the foregoing discussion of the "Sources for desirable qualities" are based upon the results of these experiments. Varieties were obtained from every wheat country of the world, aggregating about 1,000 rather distinct sorts in all. The manner of securing these wheats, and the time and labor thus involved, together with the difficulties of nomenclature arising from the confusion of varietal names which prevails generally, have all been discussed in a former bulletin on Cereal Rusts of the United States, and need not be referred to here. The varieties were grown one year in Maryland and most of them one year in Kansas, while about 300 of them were grown two years in Kansas, or three years in all; that is, during 1895, 1896, and 1897. During the same time a number of the varieties, especially from Russia, Siberia, Japan, and Argentina, were tested by other parties in cooperation with the Department, in other localities, viz, in Michigan, Wisconsin, Indiana, Tennessee, and Colorado; and in the case of a few of these, the experiments have since then been repeated in Colorado, Kansas, and Nebraska.

In conducting these experiments all the principal characteristics of the wheat plant, as shown in its different stages from that of the young plant to harvest time, were studied, though complete notes can not be given for every variety. These features include in a general way (1) the character of the young plant; (2) hardiness, including resistance to rust, drought, and cold; (3) character of the head; (4) character of the grain; and (5) time of maturity. Field experiments alone do not show those qualities of the grain which indicate the value of the variety for different uses, and which are after all more important than any others; though it must be remembered that certain characteristics of the growing plant often indicate quite correctly what these qualities will be. Therefore chemical analyses have been made of a large number of representative varieties, and for many of them the absolute weight and specific gravity of the grain have also been determined.

As would be expected, a large number of the varieties either proved to be entirely unsuited to the conditions in this country or were found to be in other respects undesirable sorts. It was the purpose from the start to discard gradually all varieties that seemed to be unable to adapt themselves to their new environment. During the first year of the experiments at Garrett Park, Md., many of them were planted so late, on account of their late arrival in this country, that much allowance must be made for their behavior in comparison with others which were sown in good season. In other respects the trial for that year was very satisfactory, and afforded an excellent opportunity of comparing the behavior and qualities of a large number of varieties under average conditions.

But the larger portion of our area most important in wheat production lies much farther westward than Maryland and possesses a very different soil and a climate characterized by great extremes of drought, cold, and heat. At the same time it is manifestly desirable to search particularly for varieties adapted to such extreme conditions for two reasons: (1) It is found that as a general rule sorts which are able to withstand the most rigorous extremes of climate are also of the class which makes the best quality of bread and macaroni, the two principal purposes for which wheat is used.[1] (2) It is comparatively easy to obtain varieties suitable for mild conditions, as those which are resistant to climatic extremes are more easily grown in a milder climate than the reverse. It was therefore decided to test the varieties during the following years in the Great Plains. Accordingly, in 1896 the field experiments were carried on at Salina, Kans., and in 1897 at Manhattan, Kans. At Salina Mr. B. B. Stimmel kindly donated the use of about two acres of land for the experiments. At Manhattan, by courtesy of the board of regents of the Kansas Agricultural College, the farm department of the experiment station was authorized to cooperate with this Department in the experiments conducted at that place, by furnishing land and other facilities for the work.

During the years of the experiments in Kansas the seasons were unusually severe even for that region. As a result it was found desirable to discard a large number of sorts from year to year. Only about 300 varieties were grown at Manhattan in 1897 out of the 1,000 originally obtained, and of these, less than 200 were selected as being worthy of continued trial. Over 100 of the varieties finally remaining have been made the basis of a large part of the series of field experiments now in progress at Halstead, Kans., while a number of the same varieties are still being tested at the Nebraska Experiment Station Farm, Lincoln, Nebr., and at the Arkansas Valley Experiment Station, Rockyford, Colo. Through this process of rigid elimination, which is a good example of the practical application of the law of the "survival of the fittest" in agriculture, about 100 varieties have been determined upon as being fairly representative sorts of the world as regards hardiness and quality of gluten content. There are many varieties, however, which can not be classed with these hardy, glutinous sorts, but which, nevertheless, because of their early maturity or particular adaptation in other respects to certain localities where hardiness is not necessary, and where these sorts would fail because of the lack of other qualities, must be considered as equally important. Palouse

[1] For the present, for the want of space, a full discussion of this proposition in detail can not be given, although the experimental proof concerning the qualities of varieties originating in regions of different climatic conditions will be brought out in connection with the table presented in the following pages. The whole matter is one of much interest and may be discussed in detail in another publication, The Relations of Soil and Climate to Wheat Production.

Blue Stem, Australian, Little Club, Early May, Allora Spring, Yemide, King's Jubilee, Early Genesee Giant, etc., are examples of this class. Adding still to these a number of other sorts, belonging to the Spelt, Emmer, and Einkorn groups, which are also hardy, but are especially valuable for certain qualities they may furnish in the work of hybridization, and then still a few others, mentioned favorably by other experimenters, we have in all 245 wheats which may be regarded as leading varieties of the world.

For comparative study the principal qualities of these 245 varieties are briefly stated in the following table, which is based mainly upon investigations of this Department, but to some extent also upon the work of others. As regards the field work, it represents a summary of the combined results of the three years' experiments, so that each column shows as nearly as can be given an average of that quality for each variety for the three years.[1]

The table is made up of twenty-five columns, and the information given in each is in most cases clearly explained by the heading, but in a few cases a little further explanation is perhaps needed. In column 2, the following abbreviations are used: C. for common or bread wheat; Cl. for club; D. for durum; P. for poulard; Pol. for Polish; S. for spelt; Em. for emmer; and Ein. for einkorn. In column 8, "stand" refers to the degree of completeness with which the plants fill the drill row, and of course often measures, though not always, the stooling quality of the variety. In column 9, under "spring condition," each number expresses in a scale of 1 to 100 the general condition of the variety in all respects about May 1. The figures in column 10 are percentages showing the comparative amount of leaf rust on the plant at the date when this rust was most abundant. This column is in the main a reproduction of the column of averages in Bul. No. 16 of this Division, Cereal Rusts of the United States, pages 26–32, table 3. Of course the smallest number represents the greatest degree of rust resistance. In column 11, the abbreviations C. and D. indicate that the variety corresponding is resistant to cold or drought and the figure shows on a scale of 1–5 how great is the degree of hardiness, 5 meaning extremely hardy. In column 19, the word "vitreous" refers to grain which is not only very hard but is somewhat transparent and presents a glassy surface in fracture. Wheats so characterized are usually durums. In column 25 is shown the particular wheat district of the United States to which the variety is best adapted. The districts are indicated by roman numerals having the following significations: I, Soft Wheat district; II, Semi-Hard Winter Wheat district; III, Southern Wheat district; IV, Hard Spring Wheat district; V, Hard Winter Wheat district; VI, Durum Wheat district; VII, Irrigated Wheat district, and VIII, White Wheat district.

[1] There is one exception. In column 9, "spring condition," the data given refer only to the experiments of 1894–95 in Maryland.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amt. of growth.	Stand.							
Algerian	D.	S.	Algeria	Lt. gr...	Erect, nar. leaf	Lrg. tall	.....	94	21	D. 5...	May 31	Bearded	Short heads, long beards.	June 22
Allora Spring	C.	W.	Australia	....do ...	Erect	Large...	Good ...	13	45	.....	May 30	(*b*)	.....	
Alsace	C.	S.	Russia	Gray gr.	Erect, velvety	....do ...	....do ...	96	24	D	June 10	Bald	.....	
American	C.	W.	United States	Dark gr.	Sprdg., fine lf.	Very lrg	....do ...	91	67	.....	May 26	Bearded	.....	June 24
American Bronze	C.	W.	.....do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Ames	C.	W.	Russia	Green ..	Erect, nar. leaf	Large...	Good ...	90	(*a*)	D. 4...	May 31	Bearded	.....	
Amethyst	C.	W.	Colorado	.....	Pntd. nar. lvs., erect.	.....	.....	92	30	.....	June 4	Bald	.....	
Arnautka	D.	S.	Russia	Lt. gr...	Erect	Large...	Poor...	91	(*a*)	D. 5...	....do ...	Bearded	.....	June 23
Arnold's Hybrid	C.	W.	United States	Yel. gr..	Nar. lvs. sprdg	....do ...	Fair	89	53	.....	May 24	Bald	.....	Do.
Assiniboine Fife	C.	S.	Canada	Lt. gr...	.....	.....	.....	97	.....	D. 3...	June 1	....do	.....	
A six rangs	.....	.....	France	Green ..	Coarse, sprdg.	Medium	Poor...	.....	26	.....	.....	Bearded	.....	
Atalanti	D.	S.	Greece	Purplish	Nar. leaves ...	Large...	.....	77	(*a*)	D	May 31	....do	.....	Do.
Australian	C.	W.	California	Lt. gr...	Drooping	.....	.....	92	.....	.....	June 11?	Bald	.....	
Australian Indian	C.	W.	Australia	Green ..	.....	Large...	Good ...	92	25	.....	May 10	.....	.....	June 20
Australian Purple Straw	C.	W.	.....do	.....	.....	.....	.....	94	.....	.....	May 31	Bald	.....	
Baggi	C.	W.	India	Lt. gr...	Slender	Tall, lrg	.....	67	.....	.....	May 14	....do	.....	June 22
Banat	C.	W.	Hungary	Green ..	Spreading	Medium	Fair	71	24	C.2, D.3	May 27	Bearded	.....	June 23
Barletta	C.	W.	Argentina	Lt. gr...	Erect	Large...	Good ...	.....	.....	.....	.....	.....	.....	
Basalt	C.	W.	Colorado	....do ...	Spreading	.....	.....	72	.....	.....	June 4	Bald	Velvet chaff..	
Bearded Winter	C.	W.	Russia	Dark gr.	.....do	Medium	V'y poor	.....	50	C.4, D.4	June 6	.....	.....	
Bellevue Talavera	C.	W.	France	Green ..	.....do	....do ...	....do ...	68	38	.....	June 4	Bald	.....	
Berthoud	C.	W.	Australia	....do ...	.....do	....do ...	Fair	72	38	.....	June 1	....do ...	Red chaff.....	
Belokoloska	C.	S.	Russia	....do ...	Erect	Large...	Good ...	.....	28	.....	June 5	....do	.....	
Beloturka	D.	S.	.....do	Lt. gr...	.....do	Medium	Fair	36	.....	D. 5...	June 1	Bearded	.....	
Bianchetta	.....	W.	Italy	Green ..	Spreading	Small...	V'y poor	.....	53	.....	June 9	Bald	.....	
Big English	C.	W.	United States	....do ...	Sprdg., fine lf.	Medium	Fair	90	50	.....	May 26	....do	.....	
Big Frame	C.	W.	.....do	.....	.....	Tall, lrg	.....	95	58	.....	May 25	....do	.....	
Black Velvet	Em.	.....	Germany	.....	.....	.....	.....	.....	(*a*)	.....	.....	Bearded	.....	
Blount's Fife	C.	W.	Colorado	.....	Spreading	.....	.....	48	.....	.....	June 11	Bald	.....	
Blount's No. 10	C.	W.	.....do	.....	Drooping	.....	.....	91	.....	.....	May 27	....do ...	White chaff...	
Blue Stem	C.	.....	United States	.....	.....	.....	.....	91	53	.....	June 7	....do	.....	
Bolton's Blue Stem	C.	S.	.....do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Buea Nera	C.	.....	Germany	.....	.....	.....	.....	.....	(*a*)	.....	.....	Bearded	.....	
Buckeye	C.	W.	United States	Green ..	Spreading	Very lrg	Good ...	92	54	.....	May 27	Bald	.....	Do.

a Almost free.

b Semibearded.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Algerian	Large	Yel'sh wh	Vitreous						V, VI, VII	
Allora Spring	Sm. or med	do	Soft			12.06	22.78	8.70	III	Plant short.
Alsace	do	Reddish	Hard			*14.88	*36.80	*13.58	IV	*Sample from Ekaterinoslav.
						†11.56	†26.50	†9.30		†Sample from Poltava.
American			S. or semih						I, II	
American Bronze			Soft	3.908		11.03	24.78	9.46	I, II	
Ames		Red	Hard						V	Lodged slightly.
Amethyst	Med. or sm	White	Soft			*13.98	*32.61	*12.03	III	*Australian sample.
Armautka	Large	Yel'sh wh	Vitreous			*16.13	*33.11	*13.04	V, VI, VII	*Sample from Kharkov.
						†14.00	†37.70	†13.55		†Sample from Poltava. Slightly lodged.
Arnold's Hybrid	Medium		Semihard						I, II	Lodged slightly.
Assiniboine Fife			Hard						IV	
A six rangs						10.69	18.38	7.42	I, II	
Atalanti	Large		Vitreous			14.38	31.72	11.65	VI, VII	Do.
Australian			Soft						VIII	
Australian Indian			do						III	
Australian Purple Straw			do						III, VIII	
Baggi	Medium	Light yel	do						III	Lodged badly.
Banat	Med. or sm	Red	Hard				*40.48		II	*Sample from Hungary.
						†14.88	†32.58	†11.60		†Sample from Russia. Lodged slightly; plant glaucous.
Barletta	Medium	Amber	Soft						I, II	
Basalt			do						I, III	
Bearded Winter	Small	Red	Hard			*15.38	*39.84	*13.87	V	Yield at Manhattan, Kans., 25 bu. per acre; in Colorado, 29½ bu. *Sample from Kharkov.
Bellevue Talavera			Soft			13.81	29.95	11.05	I, II	
Berthoud	Large	White	do							
Belokoloska	Medium	Reddish or amber,	Hard			*13.28	*32.95	*11.56	IV	*Sample from Kharkov.
						†14.19	†37.66	†13.35		†Sample from Kursk.
						‡11.56	‡24.20	‡8.58		‡Sample from Poltava.
Beloturka	Large	Yel'sh wh	Vitreous			*14.19	*34.61	*12.24	VI, VII	*Sample from Siberia. Lodged slightly.
Bianchetta										
Big English	Medium	Amber	Semihard						I, II	
Big Frame	do	do	do						I, II	Lodged badly.
Black Velvet									IV, V	
Blount's Fife	Medium		Soft			13.31	25.42	9.97	III, VII	
Blount's No. 10	do	White	do	4.690		9.45			III, VII	
Blue Stem	do	Red	Semihard						I, II	
Bolton's Blue Stem	Sm. or med	do	Hard	2.749	1.370				IV	
Buca Nera						14.19	26.67	10.63		
Buckeye	Medium	Amber	Soft						I, II	Lodged slightly.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amt. of growth.	Stand.							
Budapest	C.	W.	Hungary	Green	Spreading	Large	Fair	28	63	C.2,D.3	May 26			
Candeal Redondo	D.	W. or S.	Argentina							D				
Canning Downs	C.	W.	Australia								May 25	Bearded		
Cape	C.	W.		Lt. gr.	Drooping			81	58		May 31	Bald		
Cartagena			Spain						45					
Chernokoloska	D.	S.	Russia	Very lt. gr.	Erect	Very lrg	Good		15	D	June 7	Bearded	Short heads, black chaff.	
Chernouska		S.	do	Lt. gr.	Erect	Very vig	do	99	4	D	June 9	do		
Chiddam de Mars rouge	C.		France											
Chili			Chile								May 31	Bald		
Chili Club	Cl.		do											
China Red	C.	W.		Green	Sprdg., fine lf.	Lrg.; sht	Fair	91	38	C.3	May 23	Bearded		June 21
China Tea	C.	W.				Large	V'y good	90	38	C.3	June 4	do		
China White	C.			Green		V'y lrg; sh	Good	91	50	C.3	May 25	do		Do.
Chinese	C.	S.	China	Lt. gr.	Erect	Large	Poor							
Chubut	C.	W.	Argentina	do	Erect, coarse					D		Bearded		
Clawson	C.	W.	United States	Green		Large	Good	94	54		June 4	Bald		June 23
Cretan								86	(a)		do	Bearded		
Crimean	C.	W.	Russia	Green	Spreading	Medium	Fair		48	C.4,D.4		do		
Currell's Prolific	C.	W.	United States	do	do	do	do	91	45		June 1	Bald		
Dallas	C.	W.	do	do				89	44		May 29			
D'Arblay's Hungarian	C.	W.	Hungary	do				65			June 6	B'd'd (?)		
Daruma	C.	W.	Japan	do	Spreading	Small	Fair	75			May 27	Bearded		
Dattel	C.	W.	Germany	do	Sprdg., fine lf.	do	do	92	39		June 7	Bald		
Dawson's Golden Chaff	C.	W.	Canada	do	Erect	Medium	do		75					
Defiance	C.	W.	United States					66			June 4	Bald		
Deitz	C.	W.	do	Green		Medium	Fair	93	50		May 31	Bearded		
De la Basse	P. (?)		Egypt					40		D	do	do		
Diehl Mediterranean	C.	W.	United States					89			do	do		
Diamond Grit	C.	W.	New York	Green		Large	Fair							
Dividenden	C.		Germany						43			Bald		
Duro di Apulia			Italy	Lt. gr.	Erect, sprdg.		Poor		(a)		June 9	Bearded		
Early Arcadian	C.	W.	New York	Green		Medium	do							
Early Baart	C.	W.	Australia					76			May 27	Bearded		
Early Genesee Giant	C.	W.	New York											

a Almost free.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Budapest	Med. or sm	Red	H. or semih	2.836	1.331				I, II	
Candeal Redondo	Large	Yel'sh wh	Vitreous				35.76		VI, VII	
Canning Downs	Medium	White	Soft						III, VIII	Very short plant.
Cape	do									
Cartagena									VII, VIII	
Chernokoloska	Large		Vitreous			*15.75	*41.00	*14.68	VI, VII	*Sample from Kursk.
Chernuska	do		do			*15.94	*38.22	*14.10	VI, VII	Do.
Chiddam de Mars Rouge							10.50			
Chili			Soft							
Chili Club	Medium	Lt. yellow	do	*3.765 †4.536		*9.63 †10.50	*20.46 †22.06	*7.37 †8.19	VII, VIII	*Sample from Washington. †Sample from Oregon.
China Red	Small	Red	Hard						II, V	Lodged considerably.
China Ten	do	do	do	5.000		13.13	19.44	10.25	II, V	
China White	Medium								II	Do.
Chinese	do	Reddish	Semihard			9.44	21.20	7.80		
Chubut	do	Red	do	3.755	1.398	10.88	23.95	8.68	II	
Clawson	do	Amber	Soft	*4.242 †4.000		*10.68 †11.73	*23.35 †24.01	*8.91 †9.21	I, II	*Sample from Wisconsin. †Sample from Michigan.
Cretan	Large		Vitreous			*15.56	*42.57	*14.26	VI, VII	†Australian sample.
Crimean	Small	Red	Hard			15.25	38.97	12.91	V	Yield in Kansas 34⅛ bushels per acre.
Currell's Prolific	Medium	Reddish	S. or semih	3.098	1.316				I, II	
Dallas	do	Red	Semihard							
D'Arblay's Hungarian	do	do	Hard			14.94	31.04	10.13		
Daruma	do	Yel'sh br	Soft			10.13	21.50	8.15	III	
Dattel	do					*10.69 †13.31	*17.80 †27.63	*7.33 †10.49		*Sample from France. †Sample from Germany.
Dawson's Golden Chaff	do	Lt. yellow	Soft	3.203	1.302				I, II	
Defiance	do		do	*3.532		*13.13 †11.19	*30.90 *23.59	*11.95 †8.76	VII, VIII	*Sample from Maine. †Sample from Australia.
Deitz	do	Reddish	S. or semih							
De la Basse	Large			3.880	1.279					Plant extremely short.
Diehl Mediterranean			Semihard	*4.155 †4.186		*12.08 †14.18	*20.05 †27.51	*8.10 †10.85	I, II	*Sample from Michigan. †Sample from Indiana.
Diamond Grit	Medium	Reddish	do						I, II	
Dividenden						13.13	26.04	9.30	I, II	
Duro di Apulia										
Early Arcadian	Medium	Yel'sh br	Soft						I, II, VIII	
Early Buart			do						III	
Early Genesee Giant	Medium	Yel'sh br	do						I, II	

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amount of growth	Stand.							
Early Japanese	C.	W.	Australia					70			June 1			
Early May	C.	W.	United States	Green	Spreading	Small	Poor	89	50		May 27	Bald		June 23
Early Red Clawson	C.	W.	do	do		Very lrg	Good	86			June 4	do		Do.
Early Rice	C.	W.	do	Dark gr.	Spreading	Medium	V'y poor	94	64		May 23			June 20
Einkorn	Ein.		Germany						Rust pr'f	C.5,D.5		Bearded	Nar. comp. hds	
El Safra	D.		Algeria	V'y lt. gr	Erect, coarse	Large	Fair			D		do		
Engrain double	Ein.		France						(a)	C.4, D			Nar. comp. hds	
Entre Rios	C.	W.	Argentina	Lt. gr	Erect	Medium	Good					Bearded		
Everett's High Grade	C.	W.	United States					90						
Farquhar	C.	W.	do	Green	Spreading	Very sm	V'y poor	91	68	Cold 3	May 28	Bald	Velvet chaff	
Farrer's Durum	D.		Australia	Lt. gr	Er., v'y nar. lvs	Large	Good	69	(a)		May 31	Bearded		
Felspar	C.	W.	Colorado					89				Bald		
Fern	C.		Germany					95	28		June 11	do		
Flourelle	C.		France	Green		Medium	Poor	90	73		June 1	do		
Fluor Spar	C.	W.	Colorado					66	47		June 4	do		
Frampton	C.	W.	do								June 6	do		
Frances	C.	W.	Argentina	Lt. gr	Erect	Medium	V'y poor	91	63		June 5	do		
Frankenstein	C.		Germany					90	50		June 4	do		
Fulcaster	C.	W.	United States	Green	Spreading	Medium	Poor	91	64	C.3, D.3	May 31	Bearded		June 24
Fultz	C.	W.	do	do	do	Very vig	Fair	95	69	C.3, D	May 27	Bald	White chaff	June 22
Galland's Hybrid	P.		France	Pen. gr	Broad leaves			92	(a)		June 4	Bearded	Large	
German Amber	C.	W.		Green	Erect	Large	Good	92	60		May 27	Bald	White chaff	June 23
German Emperor	C.	W.		Dark gr.	Spreading	do	do	91	54		May 31	do		June 24
Gharnovka		S.	Russia	Lt. gr	Erect	do	Fair	98	11	D	June 11	Bearded		
Glyndon 673	C.	S.	North Dakota	do				95	60		June 1	Bald		
Glyndon 811	C.	S.	do									do		
Gold Coin	C.	W.	New York											
Golden Cross	C.	W.	do	Green	Spreading	Medium	Poor	92			May 29	Bearded		
Goldene Ane	C.		Germany					70	40			Bald		
Graf Walderdorff's Regenerated.	C.	W.	do						50			do		
Gypsum	C.	W.	Colorado	Green	Erect	Large	Good	57	33		June 1	do	White chaff	
Haffkani	C.	W.	Turkey					25	5		June 5	Bald(?)		
Hallett's Pedigree	C.	W.	England		Erect, nar. lvs.			95			June 4	Bald		
Hayne's Blue Stem	C.	S.	United States											

a Almost free.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Early Japanese	Medium	Light br.	Soft						III	
Early May	do	Light red	do						III	Lodged slightly.
Early Red Clawson	do	Red	do	{*3.844 {*4.285		*12.08 *12.25	*24.06 *26.36	*9.47 *10.15	I, II	*Sample from Indiana.
Early Rice	do		do						III	Lodged slightly.
Einkorn	Med. long	Reddish	Hard						IV, V	Plant short.
El Safra	Large	Amber yel	Vitreous						V, VI, VII	
Engrain double	Medium	Red	Hard						IV, V	
Entre Rios	do	Reddish	Soft	2.490	1.349	15.56	35.35	12.63	I, II	
Everett's High Grade	do								I, II	
Farquhar	do	Reddish	S. or semih						I, II	
Farrer's Durum	do	Yel'sh wh	Hard or vit			*14.77	*41.44	*14.49	V, VI	*Australian sample. Lodged slightly.
Felspar	do		Soft						III, VII	
Fern	do					11.56	21.67	8.10		
Flourelle										
Fluor Spar	Small		Soft			10.69	14.92	6.21	III, VII	
Frampton			do						III, VII	
Frances	Medium	Amber	do						I, II	
Frankenstein	do								I, II	
Fulcaster	Med. or sm	Red	Semihard	{*4.080 {†4.987 {‡3.913		{*12 78 {†11.73 {‡14.53	*34.13 †26.34 ‡23.98	*12.74 †10.18 ‡9.59	II, III, V	{*Sample from Pennsylvania. {†Sample from North Carolina. {‡Sample from Kentucky.
Fultz	do	Reddish	do	{*3.325 {†2.828 {‡3.844	1.361	{*11.55 {†11.90 {‡12.25	*25.03 †27.18 ‡29.13	*9.88 †10.61 ‡11.33	I, II, III, V	{*Sample from Michigan. {†Sample from Indiana. {‡Sample from Missouri.
Galland's Hybrid	Large		Hard						VI	Plant velvety, hairy.
German Amber	Medium	Light am.							I, II	Lodged slightly.
German Emperor	do		Soft			*13.13	*30.14	*10.39	I, II	*Sample from Germany.
Gharnovka	Large		Vitreous			15.38	27.30	13.90	V, VI, VII	
Glyndon 673	Small	Red	Hard						IV	
Glyndon 811	do	do	do	2.747	1.377				IV	
Gold Coin	Medium	Light yel	Soft						I, II, VIII	
Golden Cross	do		do	3.718		10.50	22.20	8.65	I, II	
Goldene Aue			do			14.38	28.63	10.70	I, II	
Graf Walderdorff's Reg'n't'd			do			14.19	30.35	10.75	I, II	
Gypsum	Medium	White	do			10.35	19.41	7.54	III, VII	
Haffkani			Semihard			12.75	25.75	9.60	III	Plant very short.
Hallett's Pedigree			Soft	*3.880		*12.08	*22.90	*9.31		*Sample from Colorado.
Hayne's Blue Stem	Med. or sm	Red	Hard	2.644	1.346				IV	

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amount of growth	Stand.							
Herisson barbu	Cl.	W or S	France					63			June 11	Bearded	Short	
Herisson sans barbes	Cl.		do									Bald	Red chaff, v'y short heads.	
Hickling									32			do		
Hopetown			England					92			June 1	do	Red chaff	
Hornblende	C.	W.	Colorado		Spreading			82	35		May 31	do		
Hudson's Early Purple Straw.	C.	W.	Australia						48		do	do	Purple straw	
Igel mit Grannen	Cl.		Germany					30	25		June 9	Bearded	Short	
Igel ohne Grannen	Cl.		do									Bald	do	
Imperial	C.	S.	Russia	Green	Erect	Very sm	V'y poor		55	D	June 16	do		
Improved Fife	C.	W.	Australia		Coarse			83	30		June 4	do		
Japanese, No. 1	C.	W.	Japan	Y'l'sh gr.	Sprdg narrow leaves.	Very lrg	Good							
Japanese, No. 2	C.	W.	do				do							V. early
Japanese, No. 4	C.	W.	do	Yel. gr.	Erect, coarse	Very lrg	V'y good							
Jejar de Valencia			Spain	Green	Spreading	Medium	Poor	85	48					
Jones's Square-head		W.	New York	do	do		V'y poor	90	74		June 4	Bald		
Jones's Winter Fife	C.	W.	do	do		Very lrg	Good	92			do	do	Velvet chaff	
Kastamuni	C.	W.	Turkey	Green	Nar. leaves	Medium	Fair	78	38	D	June 9	do		
Kathia	C.	W.	India	Lt. gr	Erect	do	V'y poor					Bearded		
Khel	C.	W.	do			Large		62			May 25	do		
King's Jubilee	C.	W.	Australia					57			May 14	Bald		June 21.
Kinney	C.		Oregon											
Kintama	C.	W.	Japan								May 30	Bearded		
Krasnokoloska	C.	S.	Russia	Lt. gr	Erect	Very lrg	Good		35	D. 3	June 16	Bald		
Kubanka	D.	S.	do	V'y. lt. gr	do	do	V'y good	35	(a)	D. 5	June 8	Bearded		
Kubb			Sweden					80	55			Bald		
Ladoga	C.	S.	Russia							D. 3				
Lal	C.		India					5			June 1	Bearded		
Lamed	C.	W.	Italy	Green	Spreading	Very lrg	Good	93		C. 3, D.	June 4	do		
Lancaster	C.	W.	United States					89		C. 3, D.	June 1	do		
Lehigh	C.	W.	do	Green	Erect	Very lrg	Good	83	63		June 4	do		
Linaza			Chile											
Little Club	Cl.	S.	United States					92		D. 3	May 23	Bald	Short, compact	
Lost Nation		W.	do					91			June 4	do	White chaff	
McKissick's Fife	C.	S.	do	Lt. gr				94	55	D. 3		do		

a Almost free.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Herisson barbu	Small	Red	Semihard.			13.31	28.06	10.18	VII, VIII	
Herisson sans barbes	do	Amber	Soft			14.19	27.60	10.20	do	Plant with large, stiff straw.
Hickling			do			10.50	20.60	7.44	I, II	
Hopetown		White	do	*4.500		*13.30			I	*Sample from Colorado.
Hornblende	Medium		S. or semih			†13.18	†45.15	†13.09	III, VII	†Australian sample.
Hudson's Early Purple Straw	Medium	White	Soft			13.65	32.19	9.55	III, VIII	
Igel mit grannen			do			11.75	21.66	7.95	VII, VIII	
Igel ohne grannen			do						do	
Imperial	Small	Red	H. or semih			12.25	19.46	9.69	IV	Did well in Wisconsin.
Improved Fife	Medium	Dull white	S. or semih			*13.87	*32.54	*11.20	II, III, VII	*Australian sample.
				†3.672		†14.18	†45.12	†16.16		†Sample from Colorado.
Japanese No. 1	do	Light br.	Soft	2.685	1.361				III, VIII	
Japanese No. 2	do	do	do						do	Escapes rust in Tennessee.
Japanese No. 4	do	do	do	2.850	1.388				do	
Jejar de Valencia						12.06	26.57	9.72		
Jones's Square-head			Soft	3.441		10.85	14.09	5.49	I VIII	
Jones's Winter Fife	Medium	Amber	do	*3.767	*1.371				I, II	*Sample from Michigan.
				4.542		11.20	20.55	8.32		
Kastamuni			Semihard			11.00	22.32	8.45	III, V, VI	
Kathia			Soft			9.16	16.74	6.47	I, II, III, VIII	
Khel			do						I, III, VIII	Lodged badly.
King's Jubilee	Medium	Dull white	do			9.25	1.50	0.69	I, III, VIII	
Kinney			do	5.368		8.93	17.09	6.69	VIII	
Kintama	Medium	Light br.	do			16.13	34.58	12.40	III, VIII	
Krasnokoloska	Med. or sm	Red	H. or semih			12.44	27.09	9.64	IV	
Kubanka	Large	Yel'sh wh.	Vitreous				*41.65			*Sample from Caucasus.
						†16.63	†37.79	†13.63	V, VI, VII	†Sample from Kursk.
						‡11.19	‡20.93	‡8.50		‡Sample from Germany.
Kubb			Soft			13.13	27.80	10.25	I, II	
Ladoga	Small	Red	Hard	4.118		15.23	30.59	12.17	IV	
Lal	Medium	Reddish				13.50	27.00	10.51	III, VIII	
Lamed	do	Red	Semihard			*12.63	*24.80	*9.50	II, V	*Sample from France.
						†11.56	†25.15	†9.02		†Sample from Italy.
Lancaster	do	do	H. or semih						I, II, V	
Lehigh			Semihard						do	
Linaza						10.69	23.28	8.50	VIII	
Little Club	Medium	Yel'sh wh.	Soft	4.225		10.15	21.61	8.32	VII, VIII	
Lost Nation	do	Red	do	*4.147		*12.08	*27.70	*10.12	I, II	*Sample from Colorado.
McKissick's Fife	Small	do	Hard						IV	

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amt. of growth.	Stand.							
Mealy	C.	W.	United States					94			May 27	Bald	Velvet chaff	
Medeah	D.	S.	Algeria					3		D.5	June 9	Bearded		
Mediterranean	C.	W.	United States					92	57	C.3,D.3	June 1	do		
Meekins	C.	W.	Russia					92		C.4,D.4	May 31	do		
Melka	C.	S.	Siberia	Green	Erect	Medium	Poor					do		
Mennonite	C.	W.	Russia	do	Sprdg. nar. lvs	do	Good	92	58	C.4,D.4	May 29	do		
Minnesota Fife	C.	S.	Minnesota			Large		80	23		May 25	Bald		
Mirado	P.	S.	Egypt (?)					50	(a)			Bearded	Velvet chaff	
Missogen	D.	S.	Greece					94	(a)		June 1	do		
Moscow	C.	W.	Russia					90	38		May 29	do		
Muzaffarnagar	C.	W.	India								June 1	do		
Mundia	C.	W.	do								do	(b)		
Murcia	D.	S.	Spain									Bearded		
Nab-el-bel	D.	S.	Algeria	V'y lt. gr	Erect, coarse	Medium	Fair							
Nashi	C.	W.	India	Green	Sprdg., very nar. leaves.	Large	V'y good	90	40	C.4,D.4	May 27	Bearded		
Nigger	C.	W.	United States	do	Spreading	Medium	Fair	91	59		May 25	do		June 23
Noé	C.		France					93	25		June 1	Bald		
Nonette de Lausanne	P.		do									Bearded		
Nonpareil	C.	W.	Australia					81			May 14	Mixed		
Odessa	C.	W.	Russia	Green	Spdg., nar. leaf	Large	Good	95	43		June 4	Bald		
Onigara	C.	W.	Japan	Yel. gr.		do	Fair	80	45		June 6	Bearded		
Oregon Club	C.	W.	United States	Green		do	V'y good	93	18		June 4	Bald	White chaff	
Palouse Blue Stem	C.	S.	Washington									do		
Penquites Velvet Chaff	C.	W.	do	Green	Spreading	Medium	Poor	91	53		June 4	Bearded	Velvet chaff	June 24
Petanielle noire de Nice	P.		France						(a)			do	do	
Pilli	C.	W.	India	Lt. gr.	Slender	Tall, l'rg		66			May 14	Bald		June 22
Pissi Hydrabadi	C.		do											
Polish	Pol.	S.	Russia	Lt. gr.	Erect			96	(a)	D.5	June 16	Bearded		
Poole	C.	W.	United States	Green	Spdg., nar. leaf	Large	Poor	94			June 1	Bald		
Power's Fife	C.	S.	North Dakota	Lt. gr.				94	53	D.3	do	do		
Pringle's Defiance	C.	W.	United States	Green	Erect, coarse	Very l.	Good	90	40		May 29	do		
Pringle's No. 5	C.	W.	do	do	Spdg., fine leaf	do	do	71	33	C.3,D.2	June 1	Bearded		June 23
Probsteier	C.	W.	Germany					70	29			Bald		
Prolifero	C.	W.	Italy	Dark gr.	Spdg., fine leaf	Large	Fair	90	40	C.3,D.3		Bearded		
Prophet	C.	W.	Persia					80	40		June 1	do		

a Almost free.

b Semibearded.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Mealy	Medium		Soft						I, II	
Medeah	Large	Yel'sh wh.	Vitreous			*14.38 †9.63	*30.20 †12.75	*11.60 †5.16	V, VI, VII	*Sample from Germany. †Sample from N. S. Wales.
Mediterranean	Small	Red	H. or semih			*11.36	*35.10	*10.86	III, V, VI	*Australian sample.
Meekins	do	do	Hard	5.193		15.15			V, VI	
Melka	do	do	H. or semih			15.25	41.19	14.59	IV	
Mennonite	do	do	Hard						V, VI	
Minnesota Fife	do	do	do						IV	Plant short.
Mirado	Large					12.66	25.05	9.24	VI, VIII	
Missogen	do	Light yel.	Vitreous			16.63	37.92	14.22	V, VI	
Moscow	Medium	Red	Hard						do	
Muzaffarnagar	L. or med.								I, II, III	
Mundia			Soft			10.34	19.16	7.61	I, III	
Murcia	Large		H. or vit			12.06	23.63	9.27	VI	
Nab-el-bel	do		Vitreous						V, VI	
Nashi	Medium	Red	H. or semih						do	Lodged greatly. Plant very glaucous.
Nigger	do	Reddish	Soft	3.947		11.73	24.03	9.77	I, II	Lodged slightly.
Noé						12.44	27.83	9.81		
Nonette de Lausanne	Large								V, VI	
Nonpareil	Medium		Soft						III, VIII	
Odessa	Small	Red	Semih. or h						II, V	
Onigara	Medium	Light br.	Soft			11.38	24.60	8.70	I, III, VIII	
Oregon Club	do	White	do	*3.647		*11.20	*23.75	*8.71	VIII	*Sample from Colorado.
Palouse Blue Stem			do	*4.572 *4.427		*13.48 *10.85	*33.76 *19.40	*12.02 *7.30	VII, VIII	*Samples from Washington.
Penquites Velvet Chaff	Medium	Red. or am	Semihard						I, II	
Petanielle noire de Nice	Large		S. or semih			10.88	23.45	8.48	VI, VIII	
Pilli			Soft						III, VIII	Lodged slightly.
Pissi Hydrabadi				3.030	1.384	9.81	28.75	6.67	do	
Polish	Very large	Yel'sh wh.	Vitreous				*46.67	*15.66	V, VI, VII, VIII	*Australian sample.
						†14.88	†29.45	†11.50		†Sample from Germany.
Poole	Medium	Amber	Soft	*4.030 †3.450		*14.00 †10.85	*32.44 †22.80	*12.48 †8.75	I, II	*Sample from West Virginia. †Sample from Indiana.
Power's Fife	Small	Red	Hard	2.683	1.375				IV	
Pringle's Defiance	Medium	White	Soft			14.93	33.16	10.62	II, VIII	
Pringle's No. 5	do		Semihard			10.19	30.70	9.78	II, V	
Probsteier	do					8.25	17.22	6.53	I, II	
Prolifero	do	Red	Semihard	3.815	1.395	12.25	24.91	9.31	II, V	
Prophet	do	Reddish	do			13.81	31.25	11.05	II	

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amt. of growth.	Stand.							
Propo	C.	.....	United States	Lt. gr	.....	.....	.....	90	45	.....	June 1	Bald	White chaff	
Pulavka	C.	W.	Russia	Green	Spreading	Large	Good	98	50	.....	June 9	Bearded	.....	
Purple Straw	C.	W.	Australia	do	Erect, nar. leaf	Very lrg	do	91	63	.....	June 4	Bald	.....	
Quartz	C.	W.	Colorado	do	Spreading	Medium	Poor	91	55	.....	May 29	Bearded	.....	
Rattling Jack	C.	W.	Australia	do	.....	Very sm	V'y poor	68	30	.....	May 31	Bald	.....	
Red Bearded	C.	W.	Russia	do	Spreading	Medium	Fair	....	57	C.3, D.3	.....	Bearded	.....	
Reddish White Bearded	C.	W.	Persia	do	.....	do	do	65	40	C. D	June 1	do	.....	
Red Fife	C.	S.	Canada	Lt. gr	.....	.....	.....	94	50	D. 3	do	Bald	.....	
Red Provence	C.	.....	France	Green	Erect, nar. leaf	Large	Fair	90	68	.....	do	do	.....	
Red Spring	Em.	S.	Germany	.....	.....	.....	.....	....	(a)	.....	.....	Bearded	.....	
Red Tyrol	S.	.....	do	.....	.....	.....	.....	....	33	.....	.....	Bald	.....	
Red Winter	C.	W.	Russia	Green	Spdg., fine leaf	Medium	Poor	....	58	C.4, D.4	June 7	Bald	.....	
Rice	C.	W.	United States	.....	Broad leaves	.....	.....	91	.....	.....	May 27	do	.....	June 21
Rieti	C.	W.	Italy	Green	Spreading	Medium	Fair	76	28	C.3, D.3	May 31	Bearded	.....	
Rio Grande	C.	S.	United States	do	.....	Small	V'y poor	91	.....	.....	do	do	.....	
Roseworthy	C.	W.	Australia	Lt. gr	Erect	Large	Poor	90	38	.....	May 10	(b)	.....	June 20
Rudy	C.	W.	Ohio	Green	Spreading	do	V'y good	89	67	.....	June 1	Bearded	.....	
Russian Hard	C.	W.	Russia	do	do	do	do	....	53	C.4, D.4	.....	do	.....	
Russian Spring	C.	S.	do	.....	.....	.....	.....	89	.....	D. 4	.....	.....	.....	
Rye Wheat	C.	W.	Germany	.....	.....	.....	.....	65	48	.....	June 7	Bald	Velvet chaff	
Safeed	C.	.....	Persia	Green	.....	Medium	Poor	....	.....	Cold	.....	Bearded	.....	
Saida	.....	.....	Egypt	.....	.....	.....	.....	....	.....	.....	May 25	do	.....	
Saldomé	C.	W.	Argentina	Lt. gr	Erect	Large	Good	....	.....	D	.....	do	.....	
Samara	C.	.....	Russia	.....	Erect, nar. leaf	.....	.....	90	(a)	D. 5	June 1	do	.....	June 23
Sandomir	C.	W.	do	Green	Spreading	Small	Poor	....	30	.....	do	Bald	.....	
Saratov	C.	.....	do	Lead	Erect, nar. leaf	.....	.....	94	.....	D. 5	June 4	Bearded	.....	
Sarui-bug-dai	D.	S.	Turkestan	.....	.....	.....	.....	....	.....	do	.....	.....	.....	
Saskatchewan Fife	C.	S.	Canada	.....	.....	.....	.....	94	63	D. 3	June 4	Bald	.....	
Saumur Winter	C.	W.	France	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	
Scoteh Fife	C.	S.	Canada	.....	.....	.....	.....	....	.....	D. 3	.....	.....	.....	
Seneca Chief	C.	W.	United States	Dark gr.	Erect	Very lrg	V'y good	91	79	.....	June 4	Bearded	.....	
Seven-headed	P.	.....	.....	Lt. gr	Erect, velvety, coarse.	Medium	Fair	94	.....	.....	June 1	do	.....	June 23
Shirosawa	C.	W.	Japan	.....	.....	.....	.....	80	.....	.....	May 30	do	.....	
Shiro-yemidashi	C.	W.	do	.....	.....	.....	.....	78	.....	.....	May 27	do	.....	
Sicilian Red Square-head	Cl.	.....	France	.....	.....	.....	.....	....	(c)	.....	June 9	Bald	Sq. shaped	

a Almost free. *b* Semibearded. *c* Rather rust resistant.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Propo	Medium	White	Soft						VII, VIII	
Pulavka	do	Light yel	do	4.205	1.354	11.88	28.30	10.43	I, VII, VIII	
Purple Straw	do	Dull white	do	5.478		8.58	18.72	7.00	III, VIII	
Quartz	do		do						III, VII, VIII	
Rattling Jack	do	White	do			10.57	29.56	8.93	VII, VIII	
Red Bearded	Small	Red	Hard	3.500	1.394				V, VI	Yield in Kansas 19¼ bu. per acre. Did well in Michigan.
Reddish White Bearded	Medium	Reddish	Semihard.	3.750	1.338	14.88	33.72	12.13	VI	
Red Fife	Small	Red	Hard	*4.105		*15.84	*37.11	*14.40	IV	*Sample from Canada.
Red Provence									I, II	
Red Spring			H. or semih						IV	
Red Tyrol									II, V	
Red Winter	Small	Red	Hard			14.19	36.38	12.77	do	Yield in Kansas, 16¾ bu. per acre; in Colorado, 27½ bu. per acre.
Rice									I, II, III	Slightly lodged.
Rieti	Med. or l.	Reddish	Semihard.			13.81	27.02	9.76	II, V	
Rio Grande	Medium	do	H. or semih	*3.276 †4.743		*11.38 †12.43	*22.25 †32.83	*9.14 †11.76	IV	*Sample from Canada. †Sample from Colorado.
Roseworthy	do	*	Soft						III, VIII	*White or light brown.
Rudy	do	Amber	Semihard.						II	
Russian Hard	Sm. or med.	Red	Hard						V	
Russian Spring	Small	do	do						IV	
Rye Wheat			Soft			*14.50 †11.88	*34.99 †23.76	*12.25 †9.20	II	*Sample from Germany. †Sample from France.
Safeed			Semihard.						II, VI	
Saida									VI	Plant very short.
Saldomé	Large	Yel'sh wh	Semihard.						do	
Samara	Small	Red	Hard						V, VI	Lodged slightly.
Sandomir	Med. or sm.	White	Soft			*10.31	*20.94	*7.94	I, II, III	Lodged considerably. *Sample from Germany.
Saratov	Small	Red	Hard						V, VI	Plant velvety hairy.
Sarui-bug-dai	Large	Yel'sh wh	Vitreous						V, VI, VII, VIII	
Saskatchewan Fife	Small	Red	Hard	3.720		14.35	30.80	12.10	IV	Sample from Wyoming.
Saumur Winter									II	
Scotch Fife	Small	Red	Hard	*4.617 †2.848		*8.75 †17.15	*12.96 †39.05	*5.13 †14.65	IV	*Sample from Oregon. †Sample from Nebraska.
Seneca Chief	Medium	Reddish	Semihard.						II	
Seven-headed									VI, VII	Lodged slightly.
Shirosawa	Medium	Light br.	Soft			10.00	20.39	7.88	III, VIII	
Shiro-yemidashi	do	do	do			16.44	37.40	13.42	do	
Sicilian Red Square-head	do	Dull red'sh	Semihard.			*15.18 10.50	*45.74 15.70	*8.98 6.30	VIII	*Australian sample.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amount of grow h	Stand.							
Sindhi			India								June 1	Bearded		
Sonora	C.	W.	Mexico	V'y lt.gr	Erect	Large		87		D. 3	May 23	Bald	Velvet chaff	
Soules	C.	W.	United States					91	72		June 1	do		
Spring Ghirka	C.	S.	Russia	Gray gr.	Erect, velvety	Large	Fair	97	36	D. 4	June 11	do		
Steinwedel	C.	W.	Australia	Lt. gr				71			May 27	do		June 24
Swamp	C.	W.	United States					91			June 1	Bearded		
Taganrog	D.	S.	Russia		Erect, nar. lvs.			90	5	D. 5	June 4	do		
Talavera	C.	W.	Australia					85			June 7	Brd'd (?)		
Tangarotto	C.	W.	Italy	Green	Spreading	Medium	Poor		(a)	C. D	May 27	Bearded		
Taos	C.	W	New Mexico											
Tasmanian Red	C.	W.		Green	Spreading	Medium	Fair	91	54		May 27	Bearded		Do.
Theiss	C.	W.	Hungary	do	do	Very sm	V'y poor	89	50		June 6	do		
Tourmaline	C.	W.	Colorado		Erect, nar. lvs.			75	67		June 7	Bald	White chaff	
Tonzelle	C.		France					90	44			Brd'd (?)		
Trimenia	C.	W.	Italy					5	(a)	D	June 9	Bearded		
Turkey	C.	W.	Russia					91		C.4, D.4	June 1	do		
Tuscan	C.	W.	Australia		Rather short			92			May 23	Bald		June 23
Urtoba	C.	W.	Germany						36			do		
Valley	C.	W.	United States					92		C. 2	May 27	Bearded		June 24
Varesotto	C.	W.	Italy	Green		Small	V'y poor	93	65	C. 3	do	do		
Velvet Blue Stem	C.	S.	United States							D. 3		Bald	Velvet chaff	
Velvet Chaff	C.	W.	do	Green	Spreading	Medium	Good	93			May 9	Bearded	do	
Victoria d'Automne	C.	W.	France						40		June 23	Bald		
Victorian Defiance	C.	W.	Australia					92	62		May 27	do		
Volo	D.	S.	Greece	Lt. gr	Erect	Medium	Fair			D	do	Bearded		Do.
Vyssoko-Litovsk	C.	W.	Russia						58		June 7	Bald		Do.
Walla Walla			United States			Large		30			May 25	Bearded		
Walker	C.	W.	do	Dark gr.	Spr'ding nar. leaves.	Medium	Fair	93	58		May 31	Bald		June 23
Ward's Prolific	C.	W.	Australia	Lt. gr	Spreading	Large	Fair	58	50		June 1	do	Reddish chaff	Do.

(a) Almost free.

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Character of the grain.								District of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten.			
							Moist.	Dry.		
Sindhi				3.315	1.386	14.38	28.52	11.11	VIII	
Sonora	Medium	Yel'sh wh	Soft	*3.830		*12.25	*36.18	*13.37	VII, VIII	Short growth. *Sample from Colorado.
Soules			do						II	
Spring Ghirka	Small	Red	Hard			*15.75	*41.23	*14.98	IV	*Sample from Samara.
Steinwedel			Soft	5.723		9.63	21.90	8.11	III, VIII	
Swamp			Semihard	2.795		14.	19.27	11.55	II	Lodged slightly.
Taganrog	Large	Yel'sh wh	Vitreous			15.06	32.75	12.15	V, VI, VII, VIII.	
Talavera			Soft						I, II	
Tangarotto	Medium	Reddish	Semihard			14.19	30.65	12.24	II, III	
Taos	do	White	Soft	4.686		9.45	21.50	7.80	VII	
Tasmanian Red	do	Red	Semihard						II, III	
Theiss	do	do	Hard			*15.38	*38.16	*12.87	do	Do.
				3.535	1.414	†12.49	†26.90	†10.12		Yield in Kansas 17½ bu. per acre; Colorado 33 bu. *Sample from Kursk. †Sample from Russia. Weight per bu. in Colorado 48 lbs.
Tourmaline	Med. or sm	White	Soft	3.058	1.383				III, VII, VIII	
Touzelle			do	*4.300		*14.18	*44.64	*14.88	I, II	*Sample from Colorado.
						11.56	26.65	9.25		
Trimenia			Vitreous			*12.63	*24.64	*9.68	V, VI, VIII	*Sample from Germany.
						†11.88	†24.04	†9.30		†Sample from Italy.
Turkey	Small	Red	Hard	*2.820		12.43	32.80	12.25	V, VI	*Sample from Kansas.
				3.128	1.334					
Tuscan			Soft						VIII	
Urtoba			do			15.56	32.95	11.95	II	
Valley	Medium	Reddish	Semihard						do	
Varesotto	do	do	do			11.75	25.00	9.08	II, V	
Velvet Blue Stem	Small	Red	Hard	*3.485		*15.49	*35.71	*13.69	IV	*Sample from South Dakota.
				†2.559		†15.23	†33.68	†13.08		†Sample from Nebraska.
Velvet Chaff		Reddish	Semihard						II	
Victoria d'Automne			Soft			10.69	15.55	6.32	I, II	
Victorian Defiance			do	4.435	1.384				I, III, VIII	
Volo	Large	Amber yel	Vitreous			*12.06	*28.00	*10.22	V, VI, VII, VIII.	Lodged slightly. *Sample from Greece.
						†15.25	†34.05	†12.45		†Sample from Germany.
Vyssoko-Litovsk	Medium	Light yel	Soft			11.88	28.76	10.35	I, VII, VIII	Yield in Kansas 19 bu. per acre.
Walla Walla			do						VII, VIII	
Walker	Medium	Reddish	Semihard						I, II	
Ward's Prolific	do	Amber	Soft	4.185	1.368				I, III, VIII	

Table presenting a comparative résumé of the principal qualities of 245 representative wheats of the world—Continued.

Name of variety.	Group.	Spring or winter.	Where obtained.	Character of growing plant.					Hardiness.		Time of heading.	Character of the head.		Time of ripening.
				Autumn condition.				Spring condition.	Resistance to leaf rust.	Resistance to cold or dr'ght.		Bald or bearded.	Other characteristics.	
				Color.	Manner of growth.	Amount of growth	Stand.							
Wellman's Fife	C.	S.	United States									Bald		
White Tuscan	C.	W.	Australia	Green	Erect	Large	Poor	25	35		June 8	do		
White Winter	C.	W.	Oregon											
Wild Goose	D.	S.	United States					89	(a)	D. 4	June 4	Bearded		
Winter Ghirka	C.	W.	Russia	Dark gr.	Spr'ding fine leaves.	Medium	Good		58	C.4, D.4	June 17	Bald		
Wyandotte Red	C.	W.	United States					93			May 31	do		
Yemide	C.	W.	Japan	Yel. gr	Erect, coarse	V'y large	V'y good	60	40		May 27	Bearded		
Yx	C.	W.	Russia	Green		Large	Fair		63	C.4, D.4		do		
Zaruta	C.	W.	Japan					50			June 1	do		
Zimmerman	C.	W.	United States	Lt. gr	Erect, nar. lvs	Large	V'y good	93	72	Cold 3	May 24	Bald		June 21

Name of variety.	Character of the grain.								Distriet of United States to which best adapted.	Remarks.
	Size.	Color.	Hardness.	Physical qualities.		Per cent of nitrogenous matter.				
				Abs. wt. 100 gr.	Sp. gr.	Albuminoids.	Gluten. Moist.	Gluten. Dry.		
Wellman's Fife	Medium	Red	Hard	2.628	1.347				IV	
White Tuscan			Soft	*5.415		*8.75	*20.94	*8.33	I, III, VII, VIII	*Sample from Australia.
						11.19	22.36	8.94		
White Winter	Medium	Yel'sh wh	do	*4.724		*8.75	*14.53	*5.58	VIII	*Both samples from Oregon.
				*4.898		*9.63	*12.33	*4.70		
Wild Goose	Large	Yel'sh br.	Hard or vit	3.697	1.379				IV, V, VI, VIII	*Sample from Canada.
				*4.655		*13.48	*32.56	*13.09		
Winter Ghirka	Small	Red	Hard	2.415	1.408	*13.63	*33.79	*12.23	II, V	*Sample from Kharkov. Yield in Kansas 18 bu. per acre; Colorado 25⅓ bu. Weight in Colorado 60 lbs. per bu.
Wyandotte Red	Medium	Reddish	Semihard						II	
Yemide	do	Light br.	Soft			11.19	20.37	7.77	III, VIII	
Yx	do	Red	Hard			15.75	41.05	13.82	II, V	Yield in Kansas 21 bu. per acre; Colorado 26⅛ bu. Weight in Colorado 61 lbs. per bu.
Zaruta	do	Light br.	Soft			10.13	20.41	7.70	III, VIII	
Zimmerman	do		Semih. or s						I, II, III, V	Lodged badly.

a Almost free.

In comparing the value of different varieties it is very desirable to know both the absolute weight and specific gravity of the grain, as these physical qualities bear some relation to the chemical composition of the grain and to the nature of the plant in general. All the information concerning specific gravity, as well as a number of determinations of absolute weight given in the table, are the results of a series of interesting investigations made in the Seed Laboratory of the Division of Botany of this Department by the late Mr. J. C. Dabney, then a member of that Division. Almost all the data of the table concerning nitrogen content of the grain are the result of chemical analyses made under the direction of Dr. H. W. Wiley, chief of the Division of Chemistry. The greater part of these analyses were made at the request of the chief of this Division with samples furnished by the Division. The remainder, together with a number of determinations of absolute weight, are taken from reports of work formerly done by the Division of Chemistry.[1] A few analyses are also given on the authority of F. B. Guthrie[2] and Emerich Pekar.[3]

As the value of the grain for making bread and macaroni is measured almost wholly by its quality and quantity of gluten content, only the percentage of moist and dry gluten and the total per cent of albuminoids are given.

It will be noted that no column for yields is given in the table. For this omission, which under other circumstances would be a serious one, there are three good reasons: (1) In experiments of this kind each variety is given so small a space (an average space of one drill row 35 feet long) that it is not practicable to obtain accurate estimates of yield. (2) Many of the varieties tested are already well-known American wheats, whose yields have often been reported by various experiment stations, while as to the foreign sorts it is most important, first of all, to know whether they will prove to be suited to our conditions at all or not, before we are ready to test their yielding capacity. (3) The yield of a variety, while it is of course directly the biggest thing to the practical man, is, after all, not a distinct constant quality in itself, but is the combined result of a number of qualities acting indirectly, and often not thought of at all. For example, such sorts as Clawson and Poole are fairly good wheats, and under mild conditions would probably yield better than Turkey; but in west Kansas or southern

[1] See "Analyses of Cereals collected at the World's Columbian Exposition," Bul. No. 45, Div. Chem., U. S. Dept. Agric., pp. 39–53, 1895.

[2] "Notes on the milling qualities of different varieties of wheat," Dept. Agric. N. S. W., misc. pub. No. 189, p. 47, 1898; "Milling notes on the Lambrigg harvest of 1897–98," Agric. Gaz. N. S. W., Vol. X, Pt. 9, pp. 906–915, Sept., 1899, and "Absorption of water by the gluten of different wheats," Dept. Agric. N. S. W., misc. pub. No. 104, p. 7, 1896.

[3] "Weizen und Mehl unserer Erde," im Auftrage des Klg. Ung. Ministeriums für Ackerbauindustrie und Handel, pp. 277, Budapest, 1882.

Nebraska they would fail entirely in certain seasons because of drought or cold, while Turkey, being very hardy, would produce a much larger yield on an average than either of the former, though its absolute yield in a good season might not be so great. So, also, it is found in the Palouse country that there are certain varieties which have absolute yields in that region greater than those of the Little Club or Palouse Blue Stem, but they shatter so badly that the net yield of the latter is greater.

As regards the field trial experiments upon which is based the larger part of the results given in the table, it must be said that many of those sorts whose behavior indicated that they would not be well adapted for our use should be further tested before adverse judgment is pronounced upon them, especially so if their qualities in other respects are good. Nevertheless, the table as a whole shows pretty accurately which are the best varieties for different districts of the country.

Nothing can be more interesting than the constant observation from year to year of the efforts being made by varieties from every country in the world, struggling with new conditions of soil and climate, to obtain a footing in a strange land. The gradual elimination of the less-adapted sorts by the severity of winter, drought, etc., soon shows unmistakably which are the varieties that will be most valuable. Of course it may truthfully be objected that mere hardiness is not of value by itself if other qualities are not also present. But, on the other hand, it is a further matter of interest how different qualities are often so closely associated in the same varieties that if a variety is adapted to a certain district with respect to one quality, it is apt to be so with respect to at least one or two other equally valuable qualities, though, of course, there are serious exceptions. It is also quite worthy of note that some apparently insignificant characteristics bear an important relation to the presence of qualities of direct economic importance. As an example of these we may note especially the characteristics of the young plant in its autumn stages in connection with the presence of certain economic qualities. Hardy winter varieties are rather slow starting in the fall, but produce good roots and soon spread out flat on the ground in preparation for the cold and snow of winter. The leaves are narrow and usually dark green or purplish at first, especially near the roots. Spring varieties and most durums and poulards, as well as some of the weaker winter sorts, on the other hand, germinate quickly and make a large growth in the autumn, but are cut short or entirely killed by the severity of the winter. They produce coarse, light-green leaves, but poor roots. In regions of mild winters durum and poulard wheats make excellent pasturage because of their rapid autumn growth. There is really very little, if any, check to the growth from seeding till harvest in localities well adapted for these varieties.

One well acquainted with wheat varieties is usually able to determine largely their general classification simply from their appearance in the autumn.

It will be seen also by a study of the table that there is a very close constant relation between hardiness, color, size, weight, and hardness of grain, and chemical composition in varieties of the common group. Varieties very resistant to cold and drought have small, hard, red grains, possessing a large proportion of albuminoids and a relatively high specific gravity, though the absolute weight is likely to be low. It is also a general rule that bearded varieties are less susceptible to leaf rust, but there are a number of important exceptions to this rule. Varieties with harsh, hairy, or glaucous leaves are also usually rather resistant to this rust. Varieties early in ripening are often dwarfed, and come from warm regions nearly always. Hard-grained winter varieties are bearded, as a rule. Drought resistant sorts, whether bald or bearded, white or red-grained, possess a larger proportion of nitrogen than those which succumb to drought.

The effect of a change of environment upon the wheat plant has already been referred to. That marked changes are effected in this way is proved, with respect to chemical composition, by the facts given in the table. In a number of instances duplicate analyses are given of samples of the same variety obtained from different localities. Almost invariably the samples from hot and more or less arid districts show a larger per cent of gluten content. In some instances the difference is considerable. Alsace wheat from Ekaterinoslav (Russia) furnishes 13.58 per cent of dry gluten, while the same variety from Poltava, farther northwest in a moister region, shows only 9.30 per cent. Improved Fife, though a much liked variety in Australia, produces but 11.20 per cent of gluten there in comparison with 16.16 per cent in Colorado. Kubanka from Kursk (Russia) possesses 37.79 per cent moist gluten and 13.63 per cent of dry gluten, while as grown in Germany it furnishes only 20.93 per cent of moist gluten and 8.50 per cent of dry gluten. At the same time a sample from the Caucasus shows 41.65 per cent of moist gluten. A remarkable difference is shown in the case of Scotch Fife from Nebraska and Oregon. The former sample contained 14.65 per cent of dry gluten, while the latter contained only 5.13 per cent, slightly over one-third as much. There is a striking example in the case of Palouse Blue Stem of a difference in gluten content between two samples from the same State, Washington. These samples, however, were no doubt from different localities, and no two regions are likely to be much more different from each other than are western Washington and the Palouse country of eastern Washington.

A most interesting example of correspondence between climate and chemical composition of the grain is exhibited in the case of samples

from Kursk. As will be seen in the table, all samples from this locality not only show a very large per cent of gluten, but also a per cent always far above that of other samples of the same varieties from other localities. The Kursk samples are uniformly so superior in this respect that one naturally looks about for an explanation. The matter is no doubt to be explained in this way: It is a fact already discussed by the writer in another publication[1] of this Department and referred to before in this bulletin that the nitrogen content of the grain is greatest in regions having black soils, extremes of temperature, and very low rainfall. In Russia extreme heat and aridity increase eastward and southward as a rule. The government of Kursk, however, presents a remarkable exception to this rule, especially as regards rainfall. The normal yearly rainfall is 16.9 inches, while in Woronetz, Tamboy, and Ekaterinoslav, east and south of it, the normal is 21 and 22 inches. It is apparently situated in an arid area, with greater rainfall all around it. At the same time the extremes of temperature are great and the soil is of the best in the "Chernozem" (black earth) region.

As before stated, all the experiments and observations which form the basis of this table have been made with the view of obtaining some reliable foundation for future wheat improvement. The general conclusions of immediate value to the wheat growers that are to be drawn from this work of the Department, and which are of rather wide application, may be stated as follows:

(1) Considering all qualities, the best wheats in the world are of Russian origin, coming particularly from eastern and southern Russia. They are resistant to cold and drought, are more or less resistant to leaf rust, and have the best quality of grain. They are fairly early in ripening and are good yielders. Under the head of remarks the yields per acre of several newly introduced Russian sorts in Kansas and Colorado are given in the table. For varieties not yet acclimated it will be seen that these yields are very good. The yields and weights per bushel in Colorado are furnished by W. F. Crawley, superintendent of the Arkansas Valley Experiment Station at Rockyford in 1897. The following may be considered as the best Russian varieties so far known: Arnautka, Kubanka, Kubanka Red Winter, Crimean, Sandomir, Ulka, Chernokoloska, Buivola, Red Winter, Bearded Winter, Yx, Odessa, Sarui-bug-dai, Ghirka Spring, Ghirka Winter, Russian, Beloturka, Mennonite, and Turkey. (See Plate VIII, Fig. 1.)

(2) The earliest ripening wheats are often dwarfed and come principally from India, Australia, and Japan, though a few are from the Mediterranean region. They are usually soft white wheats, but those from Japan are red, rather hardy, and possess a fair gluten content.

[1] Russian cereals adapted for cultivation in the United States, Bul. No. 23, Div. Bot., pp. 8–11.

FIG. 1.—GROUP OF RUSSIAN WHEATS IN EXPERIMENTAL PLATS AT GARRETT PARK, MD. (ORIGINAL.)

FIG. 2.—EXPERIMENTAL WHEAT PLATS AT GARRETT PARK, MD., SHOWING EARLINESS OF KING'S JUBILEE; 1, LEAKS; 2, KING'S JUBILEE; 3, TUSCAN; 4, PURPLE. (ORIGINAL.)

The best varieties so far known for our use from these regions are: Early Japanese, Yemide, Kintama, Japanese No. 2, Onigara, Daruma, Japanese No. 1, Japanese No. 4, Shiro-yemidashi, Allora Spring, Steinwedel, Early Baart, King's Jubilee (Plate VIII, Fig. 2), Roseworthy, Canning Downs, Kathia, and Nashi.

(3) Though varieties of Russian origin are, on the whole, the best, there are certain sorts from other countries which behave much like them. These are Fulcaster, Lancaster, Tasmanian Red, Fultz, Chubut, Prolifero, Rieti, Nashi, Mediterranean, Tangarotto, and Valley.

(4) Durum, Polish, and poulard wheats, besides being admirably adapted for making macaroni, are all rather resistant to leaf rust. The best known varieties are: Arnautka, Kubanka, Beloturka, Medeah, El Safra, Galland's Hybrid, Petanielle noire de Nice, Chernokoloska, Sarui-bug-dai, Volo, Missogen, Atalanti, Cretan, Wild Goose, Polish, and Nicaragua.

(5) Common bread wheats can not be depended upon to resist rust, but the best in this regard are: Turkey, Crimean, Pringle's Defiance, Rieti, Oregon Club, Fulcaster, Odessa, Pringle's No. 5, Mennonite, Velvet Blue Stem, Saskatchewan Fife, Mediterranean, Alsace, Nashi, Ghirka Spring, Prolifero, Bellevue Talavera, Ghirka Winter, Red Winter, Bearded Winter, Theiss, Deitz Longberry, Arnold's Hybrid, Sonora, and Banat.

(6) Einkorn resists leaf rust completely, and emmers resists it to a high degree at least.

(7) The very hardiest winter varieties are Turkey, Crimean, Red Winter, Ghirka Winter, Yx, and Bearded Winter. During the unusually severe winter at Manhattan, Kans., in 1896–97, these varieties fared very well when nearly all the experimental varieties of the regular experiment station plats at that place winterkilled, though well acclimated.

(8) Club wheats are usually soft grained and tender sorts and adapted only to mild climates, like that of California. They are excellent yielders. Among the best of them are: Little Club, California Club, Palouse Red Chaff, Sicilian Red Square-head, Herisson barbu, Herisson sans barbes, and Chili Club.

WHEAT BREEDING.

If we wish to continue our improvements in wheat culture, it is evident that we must soon depend upon other means than simply the introduction of varieties new to the country. During the earlier history of the country it was a question even whether wheat could be grown at all in many of the new regions open to settlement, and practically every variety had to be tested. Their introduction, therefore, naturally played the greater part in wheat improvement, and has continued to do so, in less measure of course, almost to the present

time. But the time will soon arrive when there will be no further varieties to introduce better than we already have. The work now being done by the Section of Seed and Plant Introduction of the Division of Botany of this Department is especially hastening the approach of this period. So far as our knowledge goes at present, there are now but two regions in the world which produce varieties likely to be of particular value to this country from which we have not already secured seed for trial in considerable amounts. These regions are (1) the northern portions of India and China, including Tibet, and (2) Abyssinia. There are still some of the very best varieties to be obtained, however, from regions already drawn upon, such as southeast Russia, Turkestan, and Japan. No more important work could be done at present than that of securing all these new sorts from different regions, for of course it is a great waste of time and labor to the wheat breeder to spend years in the production of varieties having special qualities if other sorts already possessing these qualities can be readily obtained from other countries.

But, as stated at the beginning of this report, although many valuable improvements have resulted and are likely still to result from introduction, there are often certain combinations of qualities found to be extremely desirable for a particular region which, so far as we yet know, do not exist in any one variety, native or introduced. Such ideal sorts are therefore to be acquired by improvements of the varieties now in use, which must be accomplished through hybridization and selection. Besides, in certain varieties ideal in other respects, such qualities as rust resistance, yielding capacity, etc., may exist already, but not to a sufficient degree. In such cases these qualities must be increased by selection of seed from individuals which exhibit them to the greatest degree. But manifestly the greater number of varieties one has at hand, either native or introduced, especially if these have been chosen with great care, the greater are the number of chances offered him for selecting and improving these qualities. The trial of introduced sorts, therefore, in comparison with native ones simply gives one a practical knowledge of the facts herein discussed under the heading "Sources for desirable qualities." With these facts in mind, together with those concerning characteristics and needs of the different wheat districts, one is prepared for effective work in wheat improvement.

IMPROVEMENT BY SELECTION.

During the last thirty or forty years considerable work has been done in wheat breeding through selection, though it is only a beginning in comparison with the great amount that may be done. It may be of interest to note a few of the most important instances of the actual production of new sorts in this way.

In 1862, in Mifflin County, Pa., Abraham Fultz, while passing through a field of Lancaster wheat, which is a bearded variety, found three heads of bald wheat. He sowed the seed from these heads the same year, and continued sowing a larger amount each year, until he obtained sufficient seed to distribute it pretty well over the country. It soon became a well-marked and popular variety, called Fultz from the name of the breeder, and is now the best known of American wheats. In 1871 this Department distributed 200 bushels of the wheat for seed. This variety is rather early in ripening, fairly hardy, and possesses a semihard, red grain of good quality. It comes nearest being a general purpose wheat of all our varieties, being grown with good success in nearly all parts of the country and in several foreign countries.

Next to Fultz, one of the best known of our native wheats is White Clawson, or simply Clawson. This variety originated in Seneca County, N. Y., in 1865, through the selection of certain superior heads from a field of Fultz by Garrett Clawson. On planting the grain from these heads, both a white and red-grained sort resulted the following season. The white wheat was considered the best, and the pint of seed obtained of this sort was sown, producing 39 pounds the following season. The third year after this 254 bushels were harvested, and that season the variety was distributed to other farmers. In 1871 this variety took first premium at the Seneca County fair, and in 1874 seed was distributed by this Department. Though judged inferior by millers at times, this variety has become a very popular one. It must not be confused with Early Red Clawson, a very distinct variety. It is a bald wheat, rather hardy, with soft, white, or light amber grains. Early Red Clawson, because of its earliness, has taken the place of this variety to a great extent in recent years.

One of the best of the more recently produced varieties is the Rudy, which was originated at Troy, Ohio, in 1871, by M. Rudy, through a careful propagation of the seed from a superior and distinct stool of wheat found in a large field. It is a semihard or soft reddish-grained wheat, bearded and with white chaff. It is widely grown in Ohio, Indiana, and adjoining States.

A number of the different varieties of Fife and Velvet Blue Stem of the spring-wheat States were also produced by simple selection. Wellman's Fife is a good example. In 1878 D. L. Wellman, of Frazee City, Minn., received a sample package of Scotch Fife wheat from the Saskatchewan Valley, in Manitoba. This was sown in the spring of the following year, and as a result it was found that the seed was badly mixed. Removing all plants but those of the true Fife and propagating carefully from year to year, Mr. Wellman gradually bred upward a very pure strain of the Fife, which became known as the Saskatchewan Fife. From the crop of 1881 were selected some unusually large heads, and from the seed of these as a beginning he finally produced a rather

distinct sort, now known as Wellman's Fife. In a similar manner Powers's Fife, Hayne's Blue Stem, Bolton's Blue Stem, and other sorts have been produced by the men whose names they bear.

By the process of selection an unusually good variety of white wheat for the Eastern States, usually called Gold Coin, has very recently been produced by Ira W. Green at Avon, N. Y. Several years ago he grew a field of Diehl Mediterranean, a bearded, red-grained wheat, and while passing through this field one day found a bald head possessing white grains. Planting every grain of this head, he found as a result next season that he had heads with very long beards, some with short beards, and others with none at all. The grain also was mixed, some red and some white. He desired a bald wheat, since the beards interfered with his success in woolgrowing, hence only the grains from the bald heads were again planted. From this as a beginning, a practically new variety resulted, which he called "No. 6." It has proved to be of considerable value for certain localities, and is already pretty well known. Various names have been given to it by different seedsmen, but it is best known by the name Gold Coin.

In instances like those just related the change has been so great as to produce really a new variety. But, of course, the majority of improvements made by selection do not represent such marked changes, though there is a great tendency among breeders to establish new varieties on the basis of very slight improvements. In a majority of the instances above described the circumstances too are such that one can not escape the thought that the abnormal heads found in the fields were the result of natural crosses. In fact in the cases of Clawson and Gold Coin wheats this is almost certain, since the seed from the first heads continued to produce sporting progeny, the following year. Or it is possible in the case of Gold Coin that the sporting was simply a later cropping out of this phenomena in the Diehl Mediterranean, which is itself a hybrid. Besides these cases, there are also instances mentioned by other writers which pretty well establish the fact of the occurrence of natural crosses among wheat varieties,[1] though, of course, such occurrences are rather rare. On the other hand, in the work of hybridization the selection of parent forms and the after selection of the best individuals from the sporting offspring are by far the most critical operations to be performed. Hence selection is both the most important part of all the work of wheat breeding, and is also to be considered from two rather different standpoints: (1) that of its operations in connection with hybridization (natural or artificial), and (2) in making the ordinary less striking improvements in the same

[1]See especially Rimpau's statements in his article on "Kreuzungsprodukte landwirthschaftlicher Kulturpflanzen," in Landwirthschaftliche Jahrbücher, Bd. xx, S. 347–350, 1891.

variety. The former phase will be best discussed under the subject of hybridization.

In cases like those of the different varieties of Fife and Velvet Blue Stem, such as Wellman's Fife, Hayne's Blue Stem, etc., above mentioned, as well as many others that might be described, the new sort, if it is rightly called such, has been produced by very gradual improvements during many years. It is not a selection of varieties, nor of offspring showing combinations of elements from different varieties as a result of crossing, but is simply a selection of individuals. The process is slower and the changes effected are not so great at any one time, but in the end important results may be reached.

Selection of this kind is, of course, the most common, and occurs constantly in nature, especially in connection with the qualities of rust resistance, hardiness against cold, etc. Farmers pretty generally practice a sort of selection of seed corn, and often too of potatoes, for seed. Comparatively little attention, however, is paid to the selection of wheat for seed, although the wheat plant is very susceptible to its environment, furnishing therefore many variations as a basis for excellent results in this line.

It is through this kind of work, but carried on thoroughly and systematically, that Prof. W. M. Hays, of the Minnesota Experiment Station, has attained some very interesting and practical results with the Fife and Velvet Blue Stem varieties of that region. He has practiced rigid selection with these varieties for a number of years, giving special attention to yield and quality of grain as shown by the baker's test. Certain new strains capable of giving to the farmer substantial gains over others have already been produced in this way. He has also developed a method of keeping records which is worthy of the attention of other experimenters.

In the preceding pages the special needs of different wheat districts have been discussed, and also the groups of wheats from which, in crossbreeding, the qualities for satisfying these needs may be secured. One must not forget, however, how much such qualities may be increased in the varieties already grown in the district, and should remember too, that even after great improvements have been secured through hybridization, very careful selection must be practiced in order to maintain the standard of excellence reached, especially if the variety is to be grown under conditions adverse to the production of the particular quality acquired.

Some of the most important qualities of the wheat plant that may readily be increased on any farm simply by selecting seed from those plants which exhibit these qualities to the greatest degree, are yield, drought resistance, winter hardiness, rust resistance, earliness in ripening, quality of the grain in any respect, and nonshattering. If in passing through a field certain plants are noticed which are almost or

quite free from rust, while the others are considerably rusted, and the locality should happen to be one in which rust is usually very bad, such heads should by all means be selected, sown separately, and from the progeny the most resistant individuals again selected. It must of course be noted that *all selections for seed should be made in the field.* Even selections for greater yield or for size or quality of grain can not be properly made from the harvested grain. It is fortunate that often two or more qualities may be improved by selecting the same individuals. For example, individuals that are very winter hardy are also likely to be rust resistant in many instances. Great yielding power and nonshattering may also occur in the same individual, while gluten content and drought resistance may exist together in certain others.

In an article by the writer on "Improvements in wheat culture"[1] a simple method is suggested which, if practiced, would enable any farmer to constantly and effectively improve the yield and quality of grain with little trouble, but with great profit in the end. As this method may be employed equally well for the improvement of any other quality of the plant, there is probably no more fitting way of closing the discussion of this topic than to reproduce here the description of that method with such modifications as are necessary to make it applicable for any improvement desired. It is as follows:

Begin practicing the constant use of a wheat-breeding plat of 1 acre or more from which to select seed each year. Locate this plat at different parts of the farm every two or three years, preferably in alternation with clover or other leguminous crops, and give it the best of care. Just before harvest go through a field of a good, hardy, standard variety that has given the best results in the locality, and mark plants that exhibit to the highest degree the special quality which it is desired to increase, such as freedom from rust, fertility of head, or otherwise, and which are at the same time at least as good as the average in other respects. At harvest time cut with a sickle enough of these marked plants for sowing the plat and, after thrashing them, select the largest and most vigorous seed for this purpose, by means of a screen or even by hand picking. Sow the plat early, drilling it at the average rate of about 1¼ bushels per acre. Next season use none of the field crop for seed, but select in the same manner enough of the best plants from this breeding plat for reseeding the plat and use all the remainder for sowing the general crop. In the following season and each succeeding season practice exactly the same method. In this way seed is never taken from the general crop, which can not be given the same care as the small plat, and there is a constant selection of seed which is more and more rigid every year. Moreover, there is no extra labor involved except the small amount required for seed selection each year. Of course the breeding plat should be kept constantly free from rye or other foreign heads and weeds.

[1] Yearbook United States Department of Agriculture, 1896, pages 489–498; also reprinted.

In many instances qualities that are very desirable or even necessary for a particular district are entirely lacking, or at least not present in any appreciable degree, in varieties which are in all other respects admirably adapted to the district. In such instances the improvement of the variety must be accomplished by breeding into it the desired quality from some other sort possessing it to a high degree. Though not so simple a process as that just described, and fraught with much more uncertainty in its operations, hybridization is often absolutely necessary for producing radical changes of great moment, or, in cases of emergency, for satisfying an imperative need, when the ordinary process of selection alone would either be too slow or fail entirely. The possibilities for improvement through hybridization, accompanied by discriminating selection, in the hands of skillful breeders, seem to be practically unlimited, especially in the case of a plant so closely self-fertilized as wheat. Nevertheless, comparatively little work of this kind has yet been done with the cereals, and particularly so in this country. Also the greater part of what has been accomplished, though productive of important results, has been of rather an elementary nature.

It may be advisable before continuing the discussion to give first a brief account of some of the principal wheat hybrids produced in this country. Nearly all of these new sorts have proved to be of more or less value in wheat improvement, while a few of them have become well-known factors in developing the industry. The pioneer in the production of wheat hybrids in this country is C. G. Pringle of Charlotte, Vt. Some of the most important of his hybrids are Pringle's No. 4, No. 5, and No. 6, Pringle's Best, and Pringle's Defiance. The last-named variety was produced in Vermont in 1877. In 1878 it was introduced into southern California, and has ever since been a standard sort there, particularly on account of its rust resistance. In the field experiments conducted by this Department this variety and Pringle's No. 5 have always proved to be rather hardy, rust resistant, and productive.

Prof. A. E. Blount, while connected with the Colorado Agricultural College, did much work in crossing wheats, and among a comparatively large number of hybrids produced some that are now not only well known in this country, but are among the most valuable sorts in Australia. They are used by Australian wheat breeders probably more often than any other foreign sorts as the parents of hybrids produced in that country. The most important of Blount's wheats are perhaps the following: Amethyst, Improved Fife, Hornblende, Gypsum, Blount's No. 10, Felspar, Ruby, and Granite. Gypsum (Blount's Lambrigg), Hornblende, Quartz, and Improved Fife are the most

popular in Australia. In New Mexico, where field tests of all his hybrids were last made, Ruby and Felspar are now most extensively grown. Blount's No. 10 is much prized in the northern portion of the Pacific coast district, where the variety Oregon No. 10 is probably identical with it. An important characteristic of several of Blount's hybrids is that they are rather rust resistant and it is partly for this reason that they are so much used in Australia. Improved Fife, however, has also an excellent quality of grain.

One of the very best varieties of this country, standing probably next to Fultz in popularity, is Fulcaster. It was produced in 1886 by S. M. Schindel, of Hagerstown, Md., and is a hybrid between Fultz and Lancaster. This variety is a bearded, semihard, red-grained wheat, considerably resistant to leaf rust and drought. It is grown pretty generally throught the country, but especially in the region from Pennsylvania to Oklahoma, including Tennessee and North Carolina to the southward.

Recently Professor Saunders, of Canada, has produced a number of new sorts adapted for growing in the Northern States and Canada. Perhaps a half dozen of these—such as Preston, Percy, Dawn, Alpha, Progress, and Countess—are now pretty well known.

All the hybrids just described have been produced, as a rule, in the most simple way; that is, they were the direct result usually of crosses between varieties comparatively closely allied. That they have met with so much success, therefore, is convincing evidence that most remarkable results must follow extensive hybridization experiments with this cereal when composite methods are employed with parents selected from widely different varieties. No experiments completely of this nature have been made in this country.

Composite crossing, however, is practiced by A. N. Jones, of Newark, N. Y., but always with parents comparatively closely allied. He has without doubt done the most important work in wheat hybridization in this country. Of all American wheat hybrids recently produced, Jones's varieties are to-day most widely used. In composite crossing, after one or more regular simple crosses have been made, one hybrid is either crossed with a fixed variety or with another hybrid, and the offspring of this last cross may be again crossed with another fixed variety or hybrid, and so on. In this way the variations that are always induced even in ordinary simple crosses are of course multiplied many fold, giving practically an unlimited chance of selecting from sporting progeny. The results obtained from composite crossing, therefore, even with varieties closely allied, are not to be compared with those from simple crosses.

Aside from the practice of composite methods, another feature which characterizes Jones's work is the tendency he has shown to adhere to a particular aim in all his operations. The wheats grown in New York and other Eastern States are inclined, on account of the nature of the

soil and climate, to be soft and starchy. Recognizing that the best bread flour is made from varieties containing a large proportion of gluten, Jones has given much attention to raising the standard of Eastern varieties in this regard, and has in a large measure succeeded. Of his first varieties the two most popular are his Winter Fife and Early Red Clawson. The former is descended from Fultz, Mediterranean, and Russian Velvet, and is a bald, velvet chaff wheat with amber grains, soft or semihard. It is grown chiefly in the Eastern and North Central States, and would be of great value in the Palouse country were it not for its shattering. Early Red Clawson is a hybrid

FIG. 1.—Diagram showing pedigree of Early Genesee Giant.

of Clawson and Golden Cross, the last named being a hybrid of Mediterranean and Clawson. Though in some respects similar to Clawson, it matures earlier and has a stiffer straw. It has a reddish grain. It is a bald, red-chaffed sort, with rather club-shaped, squarely formed heads. In the last eight or ten years it has become very well known in the northern winter-wheat States. Probably the next best known variety is Early Genesee Giant, which has been much grown throughout New York and Pennsylvania. As a good illustration of Jones's method of composite crossing, the full pedigree (fig. 1) of this hybrid, so far as known to the writer, is here given.

It will be noted that all its ancestors are varieties belonging to the common bread-wheat group. Yet samples of this hybrid show strik-

ingly in various ways the effects of composite crossing, especially exhibiting great improvement in vigor.

In the production of Diamond Grit (Plate IX) and Bearded Winter Fife, Jones has most nearly approached the wheats of the Plains States in gluten content. The former is a direct cross of Jones's Winter Fife with Early Genesee Giant, and is a bearded, white-chaffed, semihard, red-grained variety. Bearded Winter Fife is descended from the Winter Fife as one parent, but is hardier and possesses a grain of better quality. Another hybrid which shows well the advantages of a good ancestry is Early Arcadian (Plate IX). It is a bald, red-chaffed variety, with club and square-shaped heads and light amber grain, and is a direct cross of Early Genesee Giant with Early Red Clawson. It is very productive and of even growth in the field.

But even the method of composite crossing, productive as it is of valuable results, if practiced only with varieties closely allied, as just described, leaves still lacking some important sources for obtaining more rapidly and surely the improvements desired. For anything like perfect attainment of certain qualities it is necessary to practice composite crossing with *varieties of entirely different wheat groups*, a practice which, so far as known to the writer, has only been carried out to any great extent by John Garton, of Newton-le-Willows, England, and William Farrer, of New South Wales. In all the experiments in this country at most but two wheat groups have been drawn from, the common and club wheat groups. But by combining the composite method with the selection of varieties from widely different groups not only are the number of variations induced again multiplied many fold over those induced by the composite method in the same group, but the degree of variation also is much increased. Certain qualities may be obtained in this way that would otherwise even probably not be secured at all. For example, to secure the quality of nonshattering completely it will probably be imperative to introduce it from the spelt or emmer group, while satisfactory resistance to leaf rust must be obtained by crossing with the durums. Besides the direct advantages of increased and multiplied variations induced through selection of parents from different groups for any particular district one is thereby able also to produce sorts adapted for other very different districts, thus allowing his work to be of much wider usefulness. Thus after the production of Jones's Winter Fife, which has been so popular in the Eastern and North Central States, the introduction of the spelt element, without loss of other qualities, might have made it of even greater value for the Palouse country, where it is very much desired, but can not be used because of its shattering.

The wheat plant being so closely self-fertile, there is within it, lying dormant, a wonderful power to vary (a power far greater than in plants cross-fertilized in nature), which is thrown into action when different

D. G. PASSMORE. A. Hoen & Co. Lith. Baltimore.

HYBRID WHEATS, EARLY ARCADIAN AND DIAMOND GRIT, BY SIDE OF PARENT VARIETIES.

1, Early Red Clawson (1*a*, grains); 2, Early Arcadian (2*a*, grains); 3, Early Genesee Giant (3*a*, grains); 4, Jones's Winter Fife (4*a*, grains); 5, Diamond Grit (5*a*, grains.)

varieties are artifically crossed. But the enormous amount of variation induced by composite crossing between different wheat groups, though it must be apparent to anyone, can only be appreciated by seeing the results in the field. The writer had the opportunity of observing such results in the experimental plats of the Garton Brothers, in Lincolnshire, England. Their experiments in this line are by far the best illustration of this kind of work in the world. In certain plats were shown the offspring of the second generation from the last cross in cases of series of crosses in which parents were taken from four or even five different wheat groups. In these plats of the second year the progeny had reached the highest degree of variation, and the number of very different forms shown, which came directly, of course, from two parents, were astonishing. There were forms, apparently, of true durums, poulards, spelts, Polish, clubs, and intergradations between these groups, and in many cases characters of every group were easily observable in the same plant. There were large, small, short, long, bearded, and bald heads; velvet and smooth leaves; broad leaves, narrow leaves; leaves glaucous and not glaucous; and plants rusted and not rusted, and of all heights. (Plate X.)

Some of the practical results attained by the Gartons, which are of the greatest economic importance and which serve to show the superiority of their method of operations, should be mentioned. First, it was desired to combine with the yielding capacity of a local variety, rust resistance and tenacity of chaff. By intercrossing this variety with a spelt and a durum these requirements were readily obtained, as witnessed by the writer. But, in addition, the added fertility of the head drawn from the spelt, together, possibly, with the increased vigor of the seed which is often the result of hybridization, still further increased the yield of the original variety. These qualities could not possibly all have been secured by crossing common varieties only, since no varieties of the common group are known to be satisfactorily rust resistant, and only the spelts, emmers, and einkorns are perfectly tenacious of their chaff. In other hybrids great improvement has been made in the hardiness and gluten content of grain, size and fertility of the head, etc., while in nearly all cases the yield has been increased.

Some examples of the results in crossing oats and barley are also very interesting. Common oats have been changed into hulless sorts, but retaining something near the original size of grain, and at the same time one effect of the operations has been to so increase the length of the spikelets as to double the usual yield. The wild oat (*Avena fatua*) has been used successfully in many of these experiments, giving extra vigor and fertility to the new hybrids. In the case of barleys the yield of the six-rowed sorts has been combined with the excellent quality of grain of the two-rowed Chevalier. This

combination has been accomplished mainly by forcing fertility in the rows of sterile spikelets of the two-rowed variety. Besides the experiments with cereals, the Gartons have reached many interesting results also with the grasses, beans, and clovers.

The pedigrees of two of the Gartons' hybrid wheats are here given, both in the form of an equation and genealogically for illustration of their method, as follows:

(1) Hybrid = {[Talavera × (Hunter's White × Essex Red)] × [Hungarian Red × (Pedigree White × Black Spelt)]} × [(Pedigree White × Black Spelt) × (Hunter's White × Essex Red)]. (See fig. 2.)

(2) Hybrid = [(Black Spelt × Hardcastle White) × (Mainstay × Hungarian White)] × {[Pedigree Red × (Black Spelt × Hardcastle White)] × (White Chiddam × Hungarian Red)}. (See fig. 3.)

For many years William Farrer has been busily engaged in the work of improving wheats for Australia, especially with respect to rust

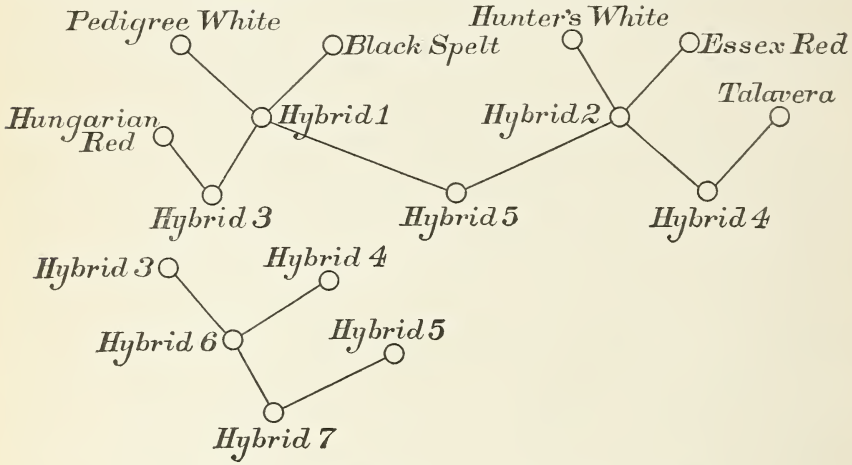


FIG. 2.—Diagram showing pedigree of one of the Gartons' hybrid wheats.

resistance, and has not only practiced composite crossing, but has found it necessary to use in many cases parent forms from different wheat groups, including common wheats, club wheats, durums, and poulards. His new varieties, although chiefly adapted to Australian conditions, are many of them most excellent ones, which show their high breeding to a marked degree, and represent an enormous amount of work. Among the very many parent varieties used in his work are the following excellent sorts: Improved Fife, Gypsum, Tourmaline, Hornblende, Quartz, Early Japanese, Beloturka, Medeah, Sicilian Red Square-head, D'Arblay's Hungarian, Zimmerman, Ward's Prolific, Fultz, Ward's White, Blount's Fife, several early maturing Indian varieties, and others that might be considered just as good as these. The following pedigree of one of his hybrids will illustrate his methods:

A COMPOSITE CROSS BY THE GARTONS, SHOWING SAMPLES OF THE PROGENY OF THE LAST CROSS.

(Redrawn from Trans. Highl. and Agric. Soc. of Scotland, Series V, Vol. VI, Pl. V.)

Hybrid = {[(Medeah × Gypsum) × Hornblende] × [Hornblende × Ward's White]} × Improved Fife. (See fig. 4.)

Medeah is a North African durum wheat. The others are common bread wheats. This new hybrid has been tested by the writer in the field experiments of this department, and was found to be a vigorous sort.

Among Continental breeders probably the most important work with cereals has been done by W. Rimpau, of Schlanstedt, Germany. Though not characterized by the use of composite methods, Rimpau's work shows a number of important examples of the results obtained by crossing with parents from different wheat groups. Some of the most interesting of the crosses showing various forms similar to the parents and intergrading as to form, color, etc., are the following: Rivett's Bearded Spelt (poulard) × Red German Bearded, Rivett's Bearded × Square-head (club group), and Mainstay × Square-head.[1]

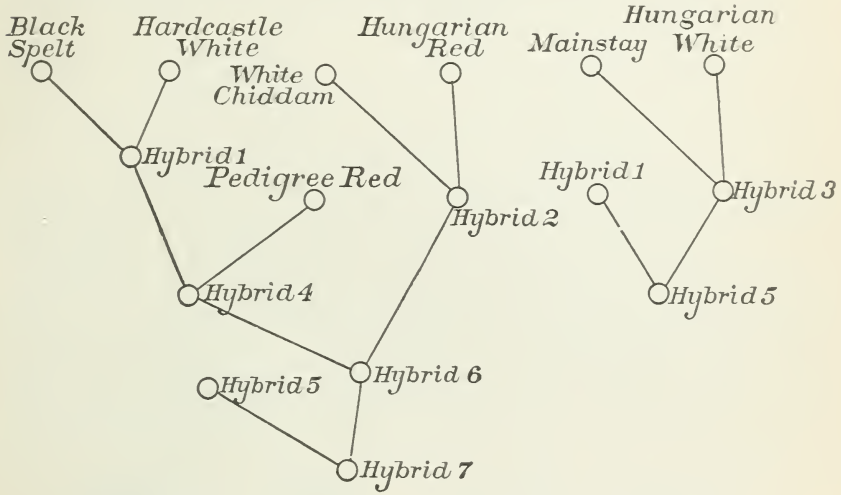


FIG. 3.—Diagram showing pedigree of one of the Gartons' hybrid wheats.

As already shown in the earlier part of this bulletin, wheat is, of all the principal cultivated crops, probably the most influenced by its environment. Connect with this the fact also of its close self-fertilization, and it is readily explained why there are so many different varieties, each best adapted to its particular district. The same variety taken to localities characterized by widely different conditions will gradually change to suit the new conditions, thus giving origin to different strains. At the same time new hybrids, when well fixed, are not likely to be broken up by subsequent natural crosses, as in the case

[1] For an interesting account of some of Rimpau's work, written by himself, see "Kreuzungsprodukte landwirthschaftlicher Kulturpflanzen." Landwirthschaftliche Jahrbücher, Bd. XX, S. 335–371 (Illus.), 1891.

of some other species. It is important, therefore, that all hybrids intended for a particular district should either be produced in that district or transferred there before they have become fixed, in order that the careful selection necessary may be continued in accordance with the tendencies developed under the influence of the new conditions.

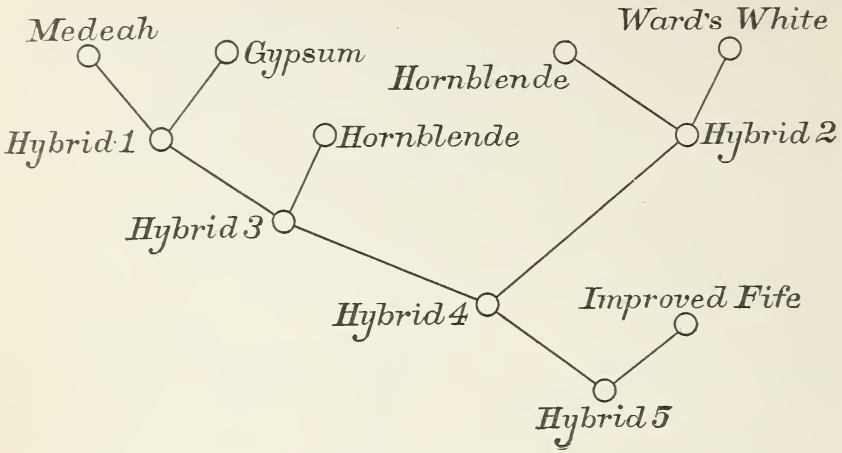


FIG. 4.—Diagram showing pedigree of one of Farrer's hybrid wheats.

Another matter of importance should be noted before leaving this topic. It was supposed for a time, and is still supposed by some, that varieties from different wheat groups will not cross with each other. Often this is true if it is attempted to cross them directly: but it shows another great advantage of composite crossing that if these same varieties are first crossed with others of the same group, or with those of groups more nearly allied, the resulting progeny will cross more readily with that of a widely different group. For example, instead of attempting to cross a common wheat with a spelt, the desired result

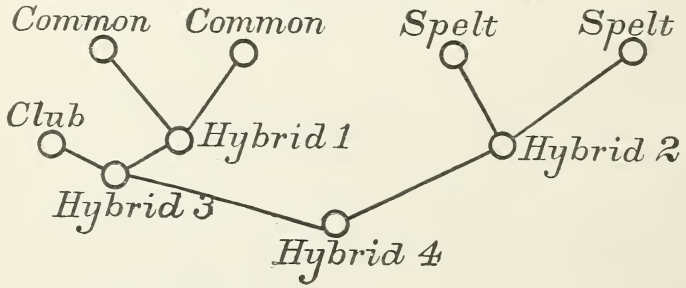


FIG. 5.—Diagram showing hypothetical cross of wheat and spelt.

would be more certainly and easily attained by means of a composite cross similar to that shown in the accompanying diagram (fig. 5), and at the same time there is a much better chance offered for selection because of the increased amount of variation thereby induced.

Through long, natural "in-and-in breeding" the qualities of the variety have become specialized, as it were, in harmony with the conditions of the environment, and do not readily amalgamate with those of a widely different sort. But once produce variation among these qualities by means of crosses with allied sorts, and it becomes easier to blend them with those of very different sorts.

SUMMARY.

1. As a foundation for rational wheat improvement, a knowledge is required of (1) the characteristics and needs of different wheat districts, and (2) the characteristic qualities of the natural groups of wheats.

2. On the basis of conditions of soil and climate and the nature of the varieties adapted to these conditions, the United States may be considered to be divided into eight wheat districts as follows: (1) Soft Wheat district, including mainly the Middle and New England States; (2) Semihard Winter Wheat district, including Ohio, Indiana, Illinois, Michigan, and a small part of Wisconsin; (3) Southern Wheat district, including approximately the Southern States; (4) Hard Spring Wheat district, covering the northern portion of the States of the Plains; (5) Hard Winter Wheat district, covering the central portion of the States of the Plains; (6) Durum Wheat district, covering the southern portion of the States of the Plains; (7) Irrigated Wheat district, including approximately the Rocky Mountain and Basin States, and (8) White Wheat district, including the Pacific Coast States.

3. Certain general needs, such as early maturity and greater yielding power, are common to all these districts and must be kept constantly in mind in connection with all efforts made to improve varieties. Other characteristics and needs are more special and are stated herewith under headings of the different districts.

4. Soft Wheat district:

(*a*) Present average yield per acre, about $14\frac{2}{3}$ bushels.

(*b*) Chief varieties now grown:

Fultz,	Longberry,
Fulcaster,	Jones's Winter Fife,
Early Genesee Giant,	Red Wonder,
Mediterranean,	Gold Coin,
Early Red Clawson,	Blue Stem.

(*c*) Needs of the grower:

Harder-grained, more glutinous varieties.
Hardier winter varieties for the most northern portions.
Early maturity.
Rust resistance.

5. Semihard Winter Wheat district:

(*a*) Present average yield per acre, about 14 bushels.

(*b*) Chief varieties now grown:

Fultz,	Valley,
Poole,	Nigger,
Rudy,	Dawson's Golden Chaff,

Early Red Clawson.

(*c*) Needs of the grower:
Hardness of grain.
Rust resistance.
Hardy winter varieties.

6. Southern Wheat district:

(*a*) Present average yield per acre, about 9⅔ bushels.
(*b*) Chief varieties at present grown:

Fultz,	Everett's High Grade,
Fulcaster,	Boughton,
Red May,	Currell's Prolific,
Rice,	Purple Straw.

(*c*) Needs of the grower:
Rust resistance.
Early maturity.
Resistance to late spring frosts.
Stiffness of straw.

7. Hard Spring Wheat district:

(*a*) Present average yield per acre, about 13 bushels.
(*b*) Chief varieties at present grown:

Saskatchewan Fife,	Wellman's Fife,
Scotch Fife,	Hayne's Blue Stem,
Powers Fife,	Bolton's Blue Stem.

(*c*) Needs of the grower:
Early maturity.
Rust resistance.
Drought resistance.
Hardy winter varieties.

8. Hard Winter Wheat district:

(*a*) Present average yield per acre, about 12⅔ bushels.
(*b*) Chief varieties at present grown:

Turkey,	May,
Fulcaster,	Zimmerman,

Fultz.

(*c*) Needs of the grower:
Drought resistance.
Hardy winter varieties.
Early maturity.

9. Durum Wheat district:

(*a*) Present average yield per acre, 11½ bushels.
(*b*) Chief varieties at present grown:

Mediterranean,	Fulcaster,
Nicaragua,	Turkey.

(*c*) Needs of the grower:
Macaroni varieties.
Drought resistance.
Rust resistance.
Early maturity.

10. Irrigated Wheat district:

(*a*) Present average yield per acre about 21 bushels.
(*b*) Chief varieties at present grown:

Sonora,	Little Club,
Taos,	Defiance,
Felspar,	Amethyst.

(*c*) Needs of the grower:
Increase of the gluten content.
Early maturity.

11. White Wheat district:

(*a*) Present average yield per acre about 14½ bushels.
(*b*) Chief varieties at present grown:

Australian,	Foise,
California Club,	Palouse Blue Stem,
Sonora,	Palouse Red Chaff,
Oregon Red Chaff,	White Winter,

Little Club.

(*c*) Needs of the grower:
Early maturity.
Nonshattering varieties.
Hardy winter varieties in the colder portions.

12. The cultivated varieties of wheat are naturally divided into eight rather distinct groups, corresponding to eight botanic species, as follows: (1) Common Bread Wheat (*Triticum vulgare*), (2) Club or Square-head (*T. compactum*), (3) Poulard (*T. turgidum*), (4) Durum (*T. durum*), (5) Polish Wheat (*T. polonicum*), (6) Spelt (*T. spelta*), (7) Emmer (*T. dicoccum*), and (8) Einkorn (*T. monococcum*). The special characteristics of these groups of wheats that are of prime importance in the work of wheat breeding are here given:

(1) Common Bread Wheat group:
(*a*) Excellence of gluten content for bread making.
(*b*) Excellence of certain varieties for cracker making.
(*c*) Yielding power of certain sorts.
(*d*) Rust resistance (in some varieties).
(*e*) Winter hardiness of certain varieties.
(*f*) Resistance to drought of certain varieties.
(*g*) Early maturity (in some varieties).

(2) Club or Square-head group:
(*a*) Great yielding power.
(*b*) Stiffness of straw.
(*c*) Freedom from shattering.
(*d*) Early maturity (in some varieties).
(*e*) Drought resistance (in some varieties).
(*f*) Excellence of certain sorts for making crackers and breakfast foods.

(3) Poulard group:
(*a*) Excellence of certain varieties for making macaroni.
(*b*) Resistance to orange leaf rust.
(*c*) Resistance to drought.
(*d*) Stiffness of straw.

(4) Durum group:
  (*a*) Excellence of gluten content for making macaroni and other pastes.
  (*b*) Resistance to drought.
  (*c*) Resistance to orange leaf rust.
(5) Polish Wheat group:
  (*a*) Quality of gluten content for making macaroni.
  (*b*) Resistance to drought.
  (*c*) Resistance to orange leaf rust.
(6) Spelt group:
  Desirable qualities—
    (*a*) Ability to hold the grain in the head.
    (*b*) Constancy in fertility.
    (*c*) Hardiness of certain winter sorts.
  Undesirable qualities—
    (*d*) Brittleness of head.
    (*e*) Rust liability.
(7) Emmer group:
  Desirable qualities—
    (*a*) Ability to hold the grain in the head.
    (*b*) Drought resistance.
    (*c*) Resistance to orange leaf rust.
  Undesirable qualities—
    (*d*) Brittleness of the head.
    (*e*) Adaptability only for spring sowing, as a rule.
(8) Einkorn group:
  Desirable qualities—
    (*a*) Ability to hold the grain in the head.
    (*b*) Resistance to orange leaf rust.
    (*c*) Hardiness.
    (*d*) Resistance to drought.
    (*e*) Stiffness of straw.
  Undesirable quality—
    (*f*) Brittleness of the head.

13. Wheats may also be grouped geographically. On this basis groups of varieties having certain special qualities are located approximately as follows:

(*a*) Starchy white wheats: Pacific Coast and Rocky Mountain States, Chile, Turkestan, Australia, and India.
(*b*) Amber or reddish grained wheats, also starchy: Eastern States, western and northern Europe, India, Japan, and Australia.
(*c*) Excellence of gluten content for making the best bread: Northern and Central States of the Plains, Canada, eastern and southern Russia, Hungary, Roumania, and southern Argentina.
(*d*) Resistance to orange leaf rust: Southern Russia, Mediterranean and Black Sea regions, and Australia.
(*e*) Excellence of gluten content for making macaroni: Southern Russia, Algeria, and the Mediterranean region in general.
(*f*) Stiffness of straw preventing lodging: Pacific Coast States, Japan, Turkestan, Mediterranean region, and Australia.
(*g*) Yielding power (at least in proportion to size of head): Pacific Coast States, Chile, and Turkestan.
(*h*) Nonshattering varieties: Pacific Coast States, Chile, Turkestan, Germany (spelts), and East Russia (emmers.)

(*i*) Constancy in fertility: Germany (spelts) and southern Europe.
(*j*) Early maturity: Japan, Australia, and India.
(*k*) Resistance to drought and heat: East and South Russia, Kirghiz Steppes, Turkestan, and southern Mediterranean region.
(*l*) Resistance to drought and cold: East Russia.

14. Of the many wheat introductions made into this country in the past, the following are among those of the greatest moment, and which have completely revolutionized the wheat industry in places:

(*a*) Mediterranean, introduced first in 1819.
(*b*) Fife wheats, introduced first into Canada and then into the northern States of the Plains.
(*c*) Turkey wheat, first introduced into Kansas about twenty-five years ago from Taurida, in Russia.
(*d*) The California Club, Australian, and Sonora, introduced into the Pacific coast States.

15. Field experiments of the Department have shown that in the common bread-wheat group there is a very close constant relation between the autumn condition of the young plant on the one hand and winter hardiness and quality of grain on the other.

16. Wheat is very susceptible to changes of environment, but especially in regard to color, hardiness, and chemical composition of the grain.

17. In general, regions possessing black prairie soils and characterized by violent climatic extremes, especially extremes of heat and drought, produce wheats that are hardiest, have the hardest grains, and are the best in quantity and quality of gluten content.

18. Considering all qualities, the best wheats of the world are of Russian origin, coming particularly from eastern and southern Russia, the Kirghiz steppes, and Turkestan. Of Russian varieties so far known, the following are among the best, if not the very best:

Arnautka,	Turkey,
Kubanka,	Ghirka Spring,
Ghirka Winter,	Russian,
Crimean,	Buivola,
Sarui-bug-dai,	Kubanka Red Winter,
Mennonite,	Yx,
Chernokoloska,	Beloturka.

19. The earliest ripening wheats are often dwarfed. The following varieties are among the best of this class:

Yemide,	Early Baart,
Onigara,	Early Japanese,
Shiro-Yemidashi,	Japanese No. 2,
Kintama,	Nashi,
Kathia,	Allora Spring,
Roseworthy,	Steinwedel,
	King's Jubilee.

20. The following varieties are among the best known of the durum and poulard groups:

Arnautka,	Galland's Hybrid,
Kubanka,	El Safra,
Beloturka,	Petanielle noire de Nice,
Chernokoloska,	Volo,
Medeah,	Missogen,
Sarui-bug-dai,	Atalanti,
Cretan,	Nicaragua.

21. Common bread wheats can not be depended upon to resist rust, but the best in this regard are probably the following:

Turkey,	Crimean,
Pringle's Defiance,	Oregon Club,
Rieti,	Odessa,
Pringle's No. 5,	Mennonite,
Nashi,	Velvet Blue Stem,
Saskatchewan Fife,	Sonora,
Theiss,	Prolifero,
Bellevue Talavera,	Mediterranean,
Arnold's Hybrid,	Deitz Longberry.

22. Einkorns resist leaf rust completely, and emmers resist it to a high degree.

23. Some of the very hardiest winter varieties so far tried in this country are:

Turkey,	Crimean,
Yx,	Ghirka Winter,

Bearded Winter.

24. Club wheats are usually soft-grained and tender sorts, adapted only to mild climates like that of California. Among the best of this group are:

Little Club,	Palouse Red Chaff,
California Club,	Chili Club,
Herisson barbu,	Sicilian Red Square-head,

Herisson sans barbes.

25. Some of the most popular and valuable wheats of our country have been produced by simple selection, though in some cases the indications are strong that they were originally the result of natural crossing. The best known of such varieties are:

Fultz,	Rudy,
Clawson,	Wellman's Fife,
Gold Coin,	Currell's Prolific.

26. Selection plays far the most important part in wheat breeding, and necessitates on the part of the experimenter a thorough knowledge of varieties and their relations to each other and to their environment.

27. Simple selection of individuals, however, for the improvement of the same variety can and should be practiced on every farm. Very little extra time or trouble is required, but the gain is great.

28. Among the most valuable wheats of the United States that have been produced through hybridization are the following:

Fulcaster,	Pringle's Defiance,
Gypsum,	Pringle's No.5,
Improved Fife,	Hornblende,
Quartz,	Felspar,
Ruby,	Blount's No. 10,
Jones's Winter Fife,	Diamond Grit,
Early Genesee Giant,	Early Red Clawson,
Early Arcadian,	Early White Leader.

29. For the most complete success in wheat improvement through hybridization it is necessary to practice composite crossing with parents selected from widely different wheat groups.

30. The wheat plant is so closely self-fertilized in nature that the practice of composite crossing produces some most interesting and remarkable results. There is apparently no end to the variations exhibited by the sporting progeny in such cases, and, accompanied by discriminating selection, the possibilities of wheat improvement in this way are practically unlimited.

INDEX OF VARIETIES.

Page.

Algerian 44, 45
Allora Spring 43, 44, 45, 63, 81
Alpha 70
Alsace 44, 45, 61, 63
American 44, 45
American Bronze 44, 45
Ames 44, 45
Amethyst 21, 44, 45, 69, 79
Amidonnier. (*See* Emmer.)
Arnautka 19, 31, 44, 45, 62, 63, 81, 82
Arnold's Hybrid 44, 45, 63, 82
A six rangs 44, 45
Assiniboine Fife 44, 45
Astrakhan 32
Atulanti 44, 45, 63, 82
Australian 22, 25, 40, 43, 44, 45, 79, 81
Australian Indian 44, 45
Australian Purple Straw 44, 45
Baggi 44, 45
Banat 28, 44, 45, 63
Barletta 44, 45
Barley wheats. (*See* Durum wheats.)
Basalt 44, 45
Bauchiger Weizen. (*See* Poulard wheats.)
Bearded Winter 44, 45, 62, 63, 82
Bearded Winter Fife 72
Bellevue Talavera 44, 45, 63, 82
Belokoloska 44, 45
Beloturka 15, 44, 45, 62, 63, 74, 81, 82
Berthoud 44, 45
Bianchetta 44, 45
Big English 44, 45
Big Frame 44, 45
Black Spelt 74, 75
Black Velvet 44, 45
Blé petanielle. (*See* Poulard wheats.)
Blount's Fife 44, 45, 74
Blount's No. 10 ..... 44, 45, 69, 70, 83
Blue Stem 13, 16, 44, 45, 77
Bolton's Blue Stem 17, 44, 45, 66, 78
Boughton 15, 78
Bread wheats 7, 26, 28, 30, 31, 32, 33, 37, 43, 63, 71, 74, 75, 76, 79
Buca Nera 44, 45
Buckeye 44, 45
Budapest 39, 46, 47
Buivola 28, 62, 81
California Club 25, 63, 79, 81, 82
Candeal Redondo 46, 47
Canning Downs 14, 46, 47, 63
Cape 46, 47
Cartagena 46, 47
Chernokoloska 46, 47, 62, 63, 81, 82
Chernouska 46, 47
Chiddam de Mars rouge 46, 47
Chili 46, 47
Chili Club 22, 46, 47, 63, 82
China Red 46, 47
China Tea 46, 47
China White 46, 47
Chinese 46, 47
Chubut 46, 47, 63
Clawson 46, 47, 59, 65, 66, 71, 82
Club wheats 22, 23, 24, 28, 29, 37, 40, 43, 63, 73, 74, 75, 76, 79, 82
Common wheats. (*See* Bread wheats.)
Composite wheats 30
Countess 70
Cretan 46, 47, 63, 82
Crimean 28, 46, 47, 62, 63, 81, 82
Currell's Prolific 15, 46, 47, 78, 82

Page.

Dallas 46, 47
D'Arblay's Hungarian 46, 47, 74
Daruma 46, 47, 63
Dattel 46, 47
Dawn 70
Dawson's Golden Chaff 14, 39, 46, 47, 77
Defiance 15, 21, 22, 46, 47, 79
Deitz 46, 47
Deitz Longberry 63, 82
De la Basse 46, 47
Diamond Grit 21, 46, 47, 72, 83
Diehl Mediterranean 46, 47, 66
Dinkel. (*See* Spelt.)
Dividenden 46, 47
Duro di Apulia 46, 47
Durum wheats 8, 15, 19, 26, 29, 30, 31, 32, 33, 37, 40, 43, 60, 63, 72, 73, 74, 75, 79, 80
Early Arcadian 46, 47, 72, 83
Early Baart 46, 47, 63, 81
Early Genesee Giant 13, 43, 46, 47, 71, 72, 77, 83
Early Japanese 48, 49, 63, 74, 81
Early May 43, 48, 49
Early Red Clawson 13, 14, 48, 49, 65, 71, 72, 77, 83
Early Rice 48, 49
Early White Leader 71, 83
Einkorn 35, 36, 37, 43, 48, 49, 63, 73, 79, 80, 82
El Safra 48, 49, 63, 82
Emmer 30, 33, 34, 35, 37, 43, 72, 73, 79, 80, 82
English wheats. (*See* Poulard wheats.)
Engrain. (*See* Einkorn.)
Engrain double 36, 48, 49
Entre Rios 48, 49
Epeautre 33
Essex Red 74
Everett's High Grade 15, 48, 49, 78
Farquhar 48, 49
Farrer's Durum 48, 49
Felspar 21, 48, 49, 69, 70, 79, 83
Fern 48, 49
Fife 16, 21, 28, 31, 38, 65, 67, 81
Flourelle 48, 49
Fluor Spar 48, 49
Foise 23, 25, 79
Frampton 48, 49
Frances 48, 49
Frankenstein 48, 49
Fulcaster 13, 15, 18, 20, 28, 48, 49, 63, 70, 77, 78, 83
Fultz 13, 14, 15, 18, 39, 48, 49, 63, 65, 70, 71, 74, 77, 78, 82
Galland's Hybrid 48, 49, 63, 82
German Amber 48, 49
German Emperor 48, 49
Gerstenweizen. (*See* Durum wheats.)
Gharnovka 48, 49
Ghirka 28, 39
Ghirka Spring 56, 57, 62, 63, 81
Ghirka Winter 58, 62, 63, 81, 82
Giant Rye. (*See* Polish wheats.)
Glasgow 38
Glyndon 673 ..... 48, 49
Glyndon 811 ..... 48, 49
Gold Coin 13, 16, 48, 49, 66, 77, 82
Golden Cross 48, 49, 71
Golden Cross Jr 71
Goldene Aue 48, 49
Golden Gate Club 22
Graf Walderdorff's Regenerated 48, 49
Granite 69
Grass. (*See* Odessa.)
Gypsum 48, 49, 69, 74, 75, 76, 83
Haffkani 48, 49

Page.

Hallett's Pedigree 48, 49
Hardcastle White 74, 75
Hayne's Blue Stem 17, 48, 49, 66, 67, 78
Herisson barbu 50, 51, 63, 82
Herisson sans barbes 50, 51, 63, 82
Hickling 50, 51
Hopetown 50, 51
Hornblende 50, 51, 69, 74, 75, 76, 83
Hudson's Early Purple Straw 50, 51
Hundred Fold 30
Hungarian Red 74, 75
Hungarian White 74
Hunter's White 74
Igel mit Grannen 50, 51
Igel ohne Grannen 50, 51
Imperial 50, 51
Improved Fife 50, 51, 61, 69, 70, 74, 75, 76, 83
Iron Straw 71
Japanese No. 1 ..... 50, 51, 63
Japanese No. 2 ..... 50, 51, 63, 81
Japanese No. 4 ..... 50, 51, 63
Jejar de Valencia 50, 51
Jerusalem Rye. (*See* Polish wheats.)
Jones's Square-head 50, 51
Jones's Winter Fife 13, 50, 51, 71, 72, 77, 83
Kastamuni 50, 51
Kathia 50, 51, 63, 81
Khel 50, 51
King's Jubilee 43, 50, 51, 63, 81
Kinney 50, 51
Kintama 50, 51, 63, 81
Krasnokoloska 50, 51
Kubanka 19, 31, 50, 51, 61, 62, 63, 81, 82
Kubanka Red Winter 62, 81
Kubb 50, 51
Ladoga 50, 51
Lal 50, 51
Lamed 50, 51
Lancaster 50, 51, 63, 65, 70, 71
Lehigh 50, 51
Linaza 50, 51
Little Club 21, 24, 25, 43, 50, 51, 60, 63, 79, 82
Longberry 13, 77
Lost Nation 50, 51
Macaroni wheat. (*See* Durum, Poulard, and Polish wheats.)
Mainstay 74, 75
May 15, 18, 78
McKissick's Fife 50, 51
Mealy 52, 53
Medeah 52, 53, 63, 74, 75, 76, 82
Mediterranean 13, 19, 20, 28, 38, 52, 53, 63, 71, 77, 78, 81, 82
Meekins 52, 53
Melka 52, 53
Mennonite 52, 53, 62, 63, 81, 82
Minnesota Fife 52, 53
Miracle 30
Mirado 52, 53
Missogen 52, 53, 63, 82
Moscow 52, 53
Mundia 52, 53
Murcia 52, 53
Muzaffarnagar 52, 53
Nab-el-bel 52, 53
Nashi 52, 53, 63, 81, 82
Nicaragua 15, 19, 20, 31, 32, 40, 63, 78, 82
Nigger 14, 52, 53, 77
Noé 52, 53
Nonette de Lausanne 52, 53
Nonpareil 52, 53
No. 6. (*See* Gold Coin.)
Odessa 39, 52, 53, 62, 63, 82
Onigara 52, 53, 63, 81
Oregon Club 52, 53, 63, 82
Oregon No. 10 70
Oregon Red Chaff 23, 25, 79
Palouse Blue Stem 16, 22, 24, 25, 40, 42, 52, 53, 60, 61, 79
Palouse Red Chaff 22, 25, 63, 79, 82
Pedigree Red 74, 75
Pedigree White 74
Penquite's Velvet Chaff 52, 53
Percy 70
Petanielle noire de Nice 52, 53, 63, 82
Pilli 52, 53
Pissi Hydrabadi 52, 53

Page.

Polba. (*See* Emmer.)
Polish wheat 31, 32, 33, 37, 43, 52, 53, 63, 73, 79, 80
Poole 14, 39, 52, 53, 59, 77
Poulard wheats 8, 26, 29, 30, 31, 37, 43, 60, 63, 73, 74, 75, 79
Power's Fife 17, 52, 53, 66, 78
Preston 70
Pringle's Best 69
Pringle's Defiance 52, 53, 63, 69, 82, 83
Pringle's No. 4 69
Pringle's No. 5 ..... 52, 53, 63, 69, 82, 83
Pringle's No. 6 69
Probsteier 52, 53
Progress 70
Prolifero 52, 53, 63, 82
Prophet 52, 53
Propo 22, 54, 55
Pulavka 54, 55
Purple Straw 15, 40, 54, 55, 78
Quartz 54, 55, 69, 74, 83
Rattling Jack 54, 55
Red Bearded 54, 55
Red Chaff. (*See* Oregon Red Chaff and Palouse Red Chaff.)
Red Chaff Club. (*See* Palouse Red Chaff.)
Reddish White Bearded 54, 55
Red Fife 54, 55
Red German Bearded 75
Red May 15, 78
Red Provence 54, 55
Red Spring 54, 55
Red Tyrol 54, 55
Red Winter 54, 55, 62, 63
Red Wonder 13, 77
Rice 15, 54, 55, 78
Rieti 54, 55, 63, 82
Rio Grande 54, 55
Rivett's Bearded Spelt 75
Rivet wheats. (*See* Poulard wheats.)
Roseworthy 54, 55, 63, 81
Ruby 69, 70, 83
Rudy 14, 23, 54, 55, 65, 77, 82
Russian 62, 81
Russian Hard 54, 55
Russian Spring 54, 55
Russian Velvet 71
Rye Wheat 54, 55
Safeed 54, 55
Saida 54, 55
Saldomé 54, 55
Salt Lake Club 22
Samara 54, 55
Sandomir 54, 55, 62
Saratov 54, 55
Sarui-bug-dai 54, 55, 62, 63, 81, 82
Saskatchewan Fife 17, 54, 55, 63, 65, 78, 82
Saumur Winter 54, 55
Scotch 38
Scotch Fife 17, 54, 55, 61, 65, 78
Seneca Chief 54, 55
Seven-headed 30, 54, 55
Shirosawa 54, 55
Shiro-yemidashi 54, 55, 63, 81
Sicilian Red Square-head 54, 55, 63, 74, 82
Sindhi 56, 57
Sonora 21, 22, 25, 40, 56, 57, 63, 79, 81, 82
Soules 56, 57
Spelt 33, 34, 35, 37, 43, 72, 73, 76, 79, 80, 81
Spelz. (*See* Spelt.)
Spring Ghirka (*see also* Ghirka Spring) 56, 57
Square-head 75
Square-head wheats. (*See* Club wheats.)
Steinwedel 56, 57, 63, 81
Swamp 56, 57
Taganrog 56, 57
Talavera 56, 57, 74
Tangarotto 56, 57, 63
Taos 21, 56, 57, 79
Tasmanian Red 56, 57, 63
Theiss 28, 39, 56, 57, 63, 82
Tourmaline 56, 57, 74
Touzelle 56, 57
Trimenia 56, 57
Triticum 25, 26
Triticum compactum 22, 26, 28, 29, 79
Triticum compositum 30
Triticum dicoccum 26, 30, 33, 34, 79

Page.

Triticum durum 8, 26, 29, 30, 79
Triticum monococcum 26, 35, 79
Triticum polonicum 26, 32, 79
Triticum spelta 26, 33, 79
Triticum turgidum 8, 26, 29, 79
Triticum vulgare 7, 8, 26, 29, 79
Turkey 17,
18, 20, 21, 28, 31, 39, 56, 57, 59, 60, 62, 63, 78, 81, 82
Tuscan 56, 57
Ulka 28, 39, 62
Urtoba 56, 57
Valley 14, 56, 57, 63, 77
Varesotto 56, 57
Velvet Blue Stem 16, 28, 31, 56, 57, 63, 65, 67, 82
Velvet Chaff 56, 57
Victoria d'Automne 56, 57
Victorian Defiance 56, 57
Volo 56, 57, 63, 82
Vyssoko-Litovsk 56, 57
Walla Walla 56, 57

Page.

Walker 56, 57
Ward's Prolific 56, 57, 74
Ward's White 74, 75, 76
Wellman's Fife 17, 58, 65, 66, 67, 78, 82
White Chiddam 74, 75
White Clawson. (*See* Clawson.)
White Michigan 39
White Polish 32
White Tuscan 58
White Winter 25, 58, 79
Wild Goose 40, 58, 63
Winter Fife. (*See* Jones's Winter Fife.)
Winter Ghirka (*see, also,* Ghirka Winter) 58
Wonder 30
Wyandotte Red 58
Yemide 43, 58, 63, 81
Yx 58, 62, 63, 81, 82
Zaruta 58
Zimmerman 18, 58, 74, 78

O